Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

J. Nat. & Phy. Sci. Vol. 24 2011 No. 1

Digitized by Arya Samaj Foundation Chennai and eGangotri

132082

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

JNPS
J. Nat. & Phys. Sc.

ISSN 097-3799

Journal of Natural & Physical Sciences

Vol. 24, No. 1, 2011

AIEAS 2011

Proceedings of
National Seminar on Innovations and
Applications in Engineering &
Applied Sciences

Gurukula Kangri Vishwavidyalaya
Haridwar-249404 (Uttarakhand), INDIA
http://www.gkvharidwar.org

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

JNPS
J. Nat. & Phys. Sc.

ISSN 097-3799

Journal of Natural &Physical Sciences

Journal Council

President (Ex-officio)	**Swatantra Kumar** Vice Chancellor
Secretary (Ex-officio)	**A.K. Chopra** Registrar
Member (Ex-officio)	**R.K. Mishra** Finance officer
Member (Ex-officio)	**Mahavir** Business Manager
	A.K. Chopra Chief Editor
	L.P. Purohit Managing Editor

Advisory Board

S.L. Singh, Rishikesh

Virendra Arora, Haridwar

H.S. Singh, Meerut

J.P. Bhatt, Srinagar (U.K.)

A.K. Sharma, Lucknow

C.S. Methela,Nainital

Rajeev Jain, Gwalior

J. Rai, Roorkee

A.P. Pathak, Hyderabad

Editorial Board

V. Kumar (Computer Science)

Mahipal Singh (Maths)

R.D. Kaushik (Chemistry)

Rajendra Kumar (Physics)

Dinesh Bhatt (Zoology & Env. Science)

Purshotam Kaushik (Botany & Microbiology)

Navneet (Botany & Microbiology)

Vipul Kumar (Engineering & Technology)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

JNPS Nat. & Phys. Sc.

Journal of Natural & Physical Sciences
Vol. 24, No. 1, 2011

ISSN 097-3799

National Seminar on Innovations and Applications in Engineering & Applied Sciences (IAEAS)

9-10 November, 2011
Faculty of Engineering & Technology
Gurukula Kangri Vishwavidyalaya, Haridwar, INDIA

ADVISORY COMMITTEE

Chief Patron
Sh. Sudarshan Sharma, *Chancellor*
Patron
Prof. Swatantra Kumar, *Vice-Chancellor*

Prof. Mahavir, *Pro-Vice Chancellor*
Prof. A. K. Chopra, *Registrar*
Mr. R.K. Misra, *Finance officer*
Prof. Virendra Arora, *Ex-Principal, College of Science*

ORGANIZING COMMITTEE

Prof. R.D. Kaushik, *Chairman*
Mayank Aggarwal, *Organizing Secretary*
Vipul Sharma, *Co-organizing Secretary*

IAEAS 2011 Proceedings

opyright © Gurukula Kangri Vishwavidyalaya, Haridwar.
o part of this journal be reproduced or transmitted in any form or by any means, electronics or mechanical ıcluding photocopying, photographic recording etc. without permission in writing from the publisher.

Published by
Registrar
Gurukula Kangri Vishwavidyalaya
Haridwar-249404 (Uttarakhand), INDIA
http://www.gkvharidwar.org

पुस्तकालय
137082
गुरुकुल कांगड़ी विश्वविद्यालय

This volume is a collection of selected papers presented in National Seminar on Innovations and Applications in Engineering & Applied Sciences (IAEAS-2011) held from 9 - 10 November 2011 at Faculty of Engineering & Technology, Gurukula Kangri Vishwavidyalaya, Haridwar.

-Chief Editor

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ISSN 097-3799

JNPS
J. Nat. & Phys. Sc.

Journal of Natural & Physical Sciences

Vol. 24, No. 1, 2011

Contents

Articles	Page No.
Square-Ring Microstrip Antenna for Circular Polarization Operation *A K Gautam, Pramod Benjwal and Rohit Negi*	1-4
Miniaturization of Microstrip Patch Antenna obtained by Patch Meandering and Shorting Pin Loading Technique *Janak Kapoor*	5-9
Comparison of Key Players of Cloud Computing on the Basis of Service Models *G.D. Makkar, Meenakshi Bist and Amit Agarwal*	11-16
Filtered-X Affine Projection Algorithm in Active Noise Control *Manikant Kumar, Modm.Farman and Vivek Kumar*	17-20
A Survey on Slip Power Recovery Drives *Nikhil Mishra, Ankit Dixit, S.M. Tripathi and K.S. Verma*	21-28
A Fixed Point Theorem of Systems of Maps on Product Spaces *Ritu Arora*	29-34
Millimeter and Microwave Photonics Devices and Their Applications *Tarun Sharma and Himanshu Monga*	35-40
BER Simulation of OFDM Signal under AWGN and Rayleigh Fading Environment *Arun Shekhar Bahuguna, Gaurav Malik, Vivek Kumar*	41-46
Synthesis, Structural and Electrical Characterization of $SrTiO_3$ Thin Films Prepared by Sol- Gel Method *Trilok Kumar Pathak, Prabha Singh, Hemendra Tripathi and L.P.Purohit*	47-51
CMOS Based Voltage Controlled Oscillator as an Application in Biomedical (Pace Maker) *Virender Sharma and Vikram Verma*	53-62
GRIDOC: Online Grid Service for Biomedical Assistance *Tarang Arora, Devendra Kumar and Amit Agarwal*	63-67
Mobile Agent Model for IT in Education System *Savita Nawani, Mayank Aggarwal and Amit Agarwal*	69-75
Impact of Ethics on Innovations and Applications in Engineering Applied Sciences and Society *Dinesh Chandra Semwal*	77-82
Sanskrit: A Programming Language *Suyash Bhardwaj and Poornima Tyagi*	83-87

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

JNPS
J. Nat. & Phys. Sc.

ISSN 097-3799

Journal of Natural &Physical Sciences

Guidelines for Authors

The manuscript should be typed in double spacing preferably in MS word leaving wide margins.

The manuscripts should be arranged as follows: The first page should contain (in following order) Title, Author's names and Address (one author should be identified as corresponding author with email id), Abstract, Keywords & Phrases, Classification number. Next page should start with usual headings of Introduction, Material and methods/Theoretical formulation, Results, Discussion, Conclusion, Acknowledgment (if any) and References. In the text the authors should delete their names and authors identification from the properties of the file.

To ensure the integrity of the blind peer-review for submission to this journal, every effort should be made to prevent the identities of the authors and reviewers from being known to each other.

Figures

Figures (refer with: figure 1, figure 2, ...) also should be presented as part of the text, leaving enough space so that the caption will not be confused with the text. The caption should be self-contained and placed below the figure. For best quality the pictures should have a resolution of 300 dpi (dots per inch).

Equations

Equations (refer with: Eq. (1), Eq. (2), ...) should be indented 5 mm (0.2"). There should be one line of space above the equation and one line of space below it before the text continues. The equations have to be numbered sequentially, and the number put in parentheses at the right-hand edge of the text.

References

References should be cited in the text just by square brackets [1]. Two or more references at a time may be put in one set of brackets [3,4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the manuscript under a heading References, see example below.

[1] Van der Geer, J.A.J. Hanraads, R.A. Lupton, The art of writing a scientific article, *J Sci. Commun.* 163 (1), 51-59 (2000).

Reference to a book/ chapter in an edited book

[2] W. Strunk Jr., E.B. White, The Elements of Style, third ed., *Macmillan, New York*, 1979.

[3] G.R. Mettam, L.B. Adams, How to prepare an electronic version of your article, in: B.S. Jones, R.Z. Smith (Eds.), Introduction to the Electronic Age, *E-Publishing Inc., New York*, 281-304, 1999.

[4] Information on http://www.weld.labs.gov.cn

Reference should not be made to unpublished work like Ph. D. thesis or papers communicated.

Reprints

Twenty five reprints will be supplied free of cost. Additional reprints may be supplied at printer's cost.

Exchange of Journals

Journals in exchange should be sent to the Chief Editor or Librarian.

Subscription

Each volume of the journal is currently priced at Indian Rs. 500 in SAARC countries and US $ 100 elsewhere.

Copyright © Gurukula Kangri Vishwavidyalaya, Haridwar.

The advice and information in this journal are believed to be true and accurate but the person associated with the production of the journal can not accept any legal responsibility for any errors or omissions that may be made.

Contact for :-

Submission of Manuscript
Chief Editor/Managing Editor
Journal of Natural & Physical Sciences
Gurukula Kangri Vishwavidyalaya
Haridwar - 249404, Uttarakhand, INDIA
E-mail : editorjnps@gmail.com ; editorjnps@gkvharidwar.org

Subscription
Librarian
Central Library
Gurukula Kangri Vishwavidyalaya
Haridwar - 249404, Uttarakhand, INDIA

http://www.gkvharidwar.org /jnps.html

For further information mail to:
Prof. A.K. Chopra, Chief editor (profakchopra@gmail.com); Dr. L.P. Purohit, Managing editor (lppurohit@gmail.com)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
J.Nat. & Phys. Sc.
Vol. 24,No.1, pp. 1-4 (2011)

Square Ring Microstrip Antenna for Circular Polarization Operation

A K Gautam, Pramod Benjwal# and Rohit Negi
Department of Electrical & Electronics Engineering, G B Pant Engineering College, Pauri Garhwal (Uttarakhand), India
#Corresponding author (**Email**: pramodben@gmail.com)

ABSTRACT- A square ring microstrip antenna with truncated corners is presented for compact circular polarization operation. Simulated antenna has a reduced antenna size and centre frequency as compared to the conventional circularly polarised square microstrip antenna with truncated corners at a given operating frequency. Different structures are simulated and results are compared. Square ring with inner dimensions 11×11mm microstrip antenna with truncated length 4.8mm shows 25.23% size reduction as compared to microstrip antenna without ring and truncated length 3.2mm with VSWR 1.6 and return loss −14.53dB for entire range of frequencies. It is observed that as the ring size increases the antenna becomes more compact. Simulation of all antennas are carried out for radiation pattern, return loss and input impedance etc.

KEYWORDS: Ring, Truncated corner microstrip antenna, CP microstrip antenna, Microstrip antenna.

1. INTRODUCTION

One of the important advantages for microstrip antenna is its small size and can be constructed very precisely due to its construction method. Its other advantages are: low in profile, light in weight, low cost, MMIC compatible, conformable in structure, flexibility with regard to frequency, polarization, pattern and impedance, and suitability of mass production. It has been found suitable in satellite communications, radars, missiles, high-speed space vehicles, other strategic defence equipments and mobile communication due to compatibility with planar solid-state devices in addition to diversified applications [1]. Miniaturization is the major requirement of mobile communication. Due to light weight, easy production, conformability and so forth have increased interest in designing of such microstrip antennas [2]. In this class of antennas, the annular-ring microstrip antennas exhibit interesting features associated with the annular ring patch [3–6]. For a given frequency, these antennas, when operating in the fundamental mode, have smaller size as compared to the rectangular or circular patch antennas. This characteristic allows the antenna elements in array designs to be more compact, favoring the flexibility and the miniaturization of the antenna arrays. The small size is an important requirement for portable communication equipments. The major advantage of single-feed circularly polarized microstrip is its simple structure [7]. Moreover, the impedance bandwidth of patch antenna is proportional to the antenna dimensions measured in wavelengths. Therefore, the size reduction and bandwidth enhancement are becoming major design considerations and usually demanded for practical applications.

In view of the above, detailed analysis and the simulation of a single feed square ring microstrip antenna with truncated corners for compact size and circular polarisation operation is carried out. Proposed antenna has reduced antenna size and centre frequency as compared to the conventional circularly polarised square microstrip antenna with truncated corners at a given operating frequency. Other antennas are also simulated in MoM based simulator and optimized for the best results. The analysis and simulation are carried out in the following sections.

2. ANTENNA DESIGN AND SIMULATION

Figure 1 shows the truncated square reference microstrip antenna with the dimension of 28 × 28 mm^2 and truncated length 3.2mm. The substrate has thickness of 1.6mm and dielectric constant 4.4. The antenna corners

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

are truncated with equal side lengths Δ.L. The initial truncation length is kept 1mmwhich is subsequently increased by 0.5 mm in each successive step. The designs were then simulated and it is found that the maximum return loss is achieved with truncation length of 3.2 mm and beyond which it reduced rapidly. Left hand CP operation was obtained by moving the feed position from point 'A' to a point in x-axis. The proposed single feed square-ring microstrip with truncated corners for compact circular polarization operation is shown in figure 2. The square patch having an outer side length L_1 = 28 mm and an inner side length of L_2 = 11 mm with substrate thickness h and relative permittivity = 4.4 same as reference antenna. The truncated corners are of equal length L= 4.8mm. Left-hand CP operation is obtained by moving feed position on x-axis from the centre point O. Probe feed distance is denoted by d_p. If the feed point is moved on y-axis then right hand CP operation is obtained. Many other designs are also successfully simulated. It is then observed that as the ring size and truncation length are increased the percentage of size reduction increases.

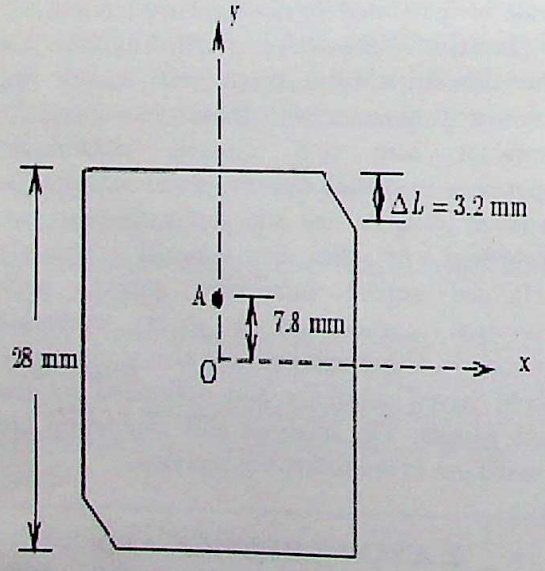


Fig. 1: Geometry of square microstrip antenna with truncated corners.

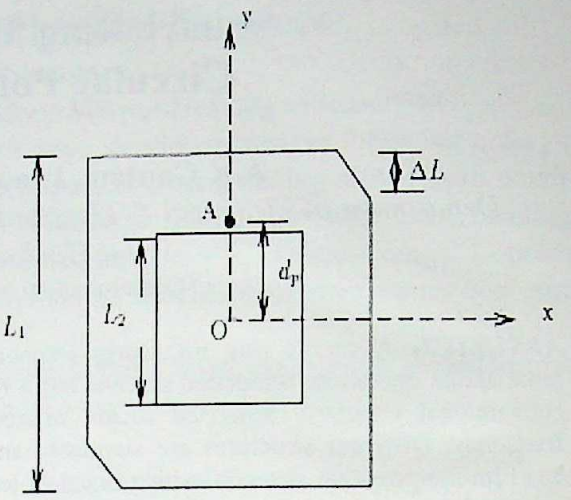


Fig. 2: Geometry of Square-ring microstrip antenna with truncated corners for CP operation.

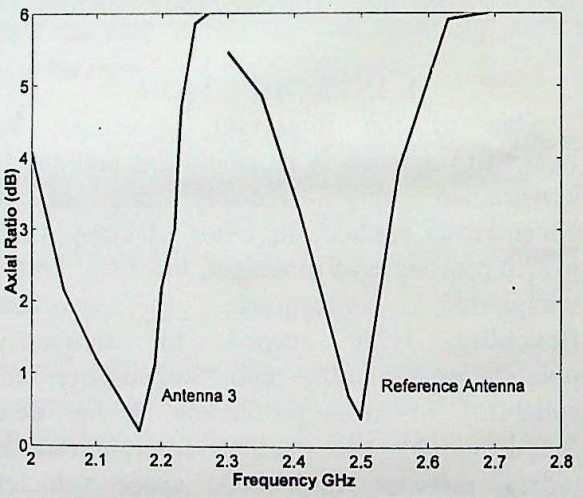


Fig.3: Axial ratio in broad side direction for proposed antenna and reference antenna.

3. RESULTS AND DISCUSSION

The several antenna designs are successfully simulated in IE3D [8] for input impedance, return loss, VSWR, axial ratio and radiation pattern. The simulation of the axial ratio with frequency in broadside direction and the size reduction for all antennas are shown in figure 3 and figure 4. It is observed that the axial ratio is minimum for the resonance frequency, 2.1671 GHz for antenna-3, 2.26 GHz for antenna-2, 2.314 GHz for antenna-1 and 2.5 GHz for reference antenna. The resonance of the antenna-3 is 11.54% down as compared to reference antenna. Thus, for a fixed operating frequency the lowering of the resonance

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

frequency corresponds to an antenna size reduction of 25.23% by using proposed design as compared to the reference antenna.

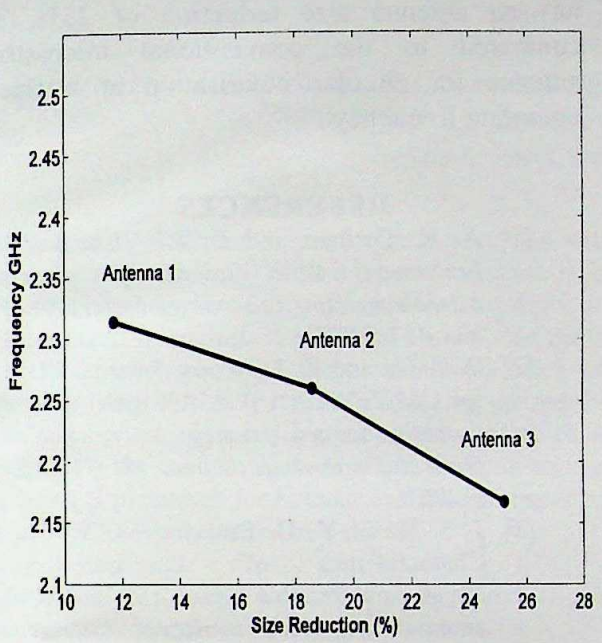


Fig. 4: % Size reduction with the frequency for different antennas.

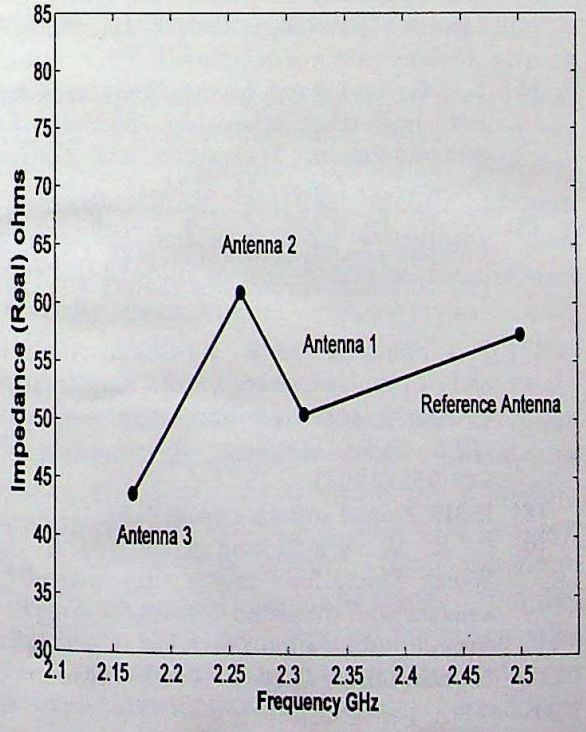


Fig. 5: Variation of Impedance with frequency for different antennas.

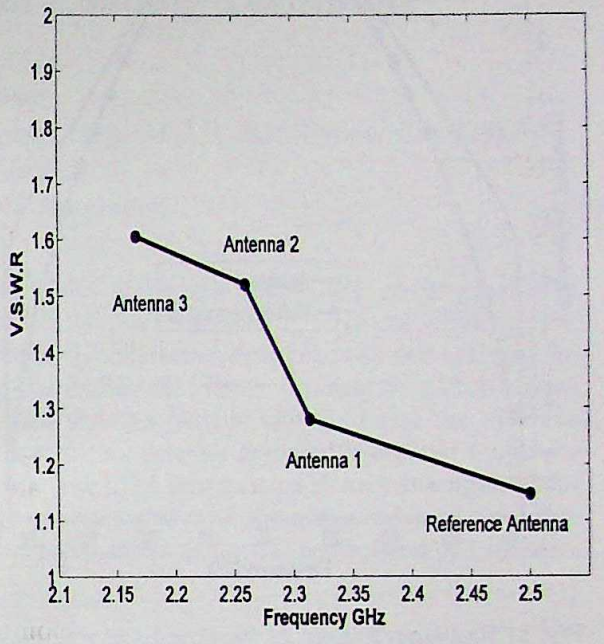


Fig. 6: Variation of VSWR with frequency for different antennas.

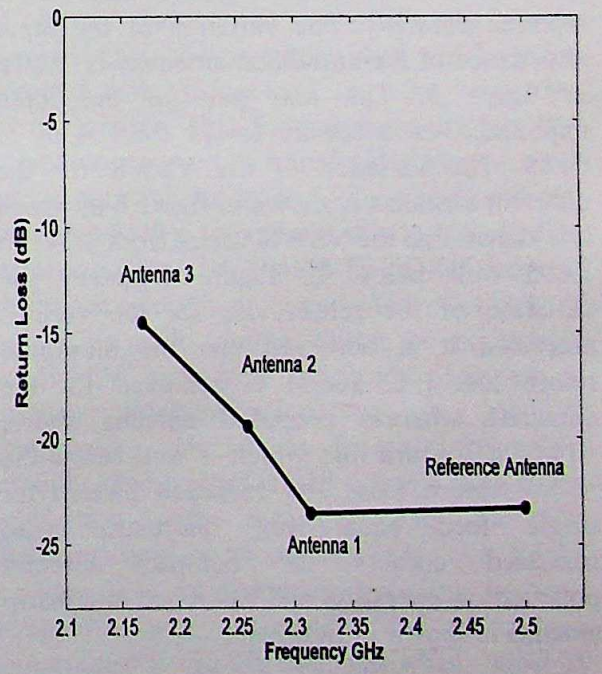


Fig. 7: Variation of Return loss with resonance frequency for different antennas.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

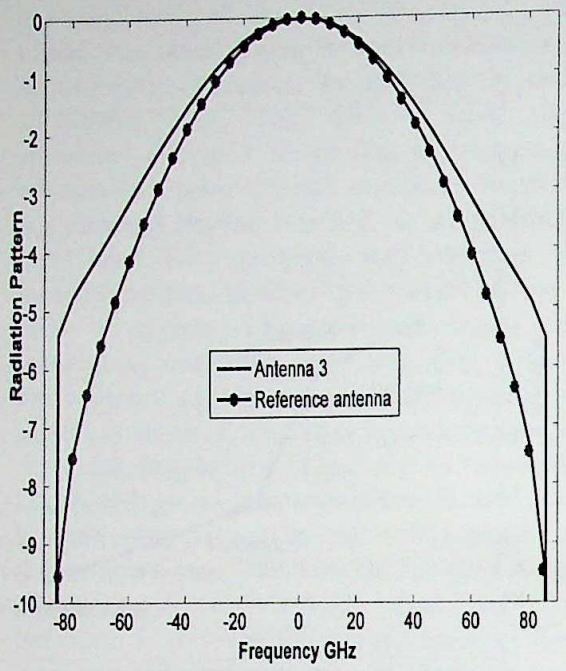


Fig. 8: Radiation Pattern of Proposed and reference antenna.

It is also found that proposed antenna is the most compact antenna with maximum size reduction of 25.23% with respect to the reference antenna which is greater than earlier reported data [9]. The variation of the input impedance of the simulated antennas is shown in figure 5. The real part of the input impedance of antennas varies from 43.6 to 60.89. The variation of the VSWR for the different antennas is shown in figure 6 in which it is shown that the VSWR varies from 1.147 to 1.605 well below 2. Figure 7 shows the variation of the return loss for the various antennas. It is observed that the minimum return loss (−23.56dB) is achieved for the antenna1 whereas proposed antenna shows −14.53 dB return loss which is well below the −10dB return loss. The radiation pattern for single feed square-ring microstrip with truncated corners for compact circular polarization operation and reference microstrip antenna is shown in figure 8.

4. CONCLUSION

The square ring microstrip antenna for circular polarization operation has been successfully simulated. The proposed antenna has an antenna size reduction of 25%, as compared to the conventional microstrip antenna for circular polarisation at a fixed operating frequency.

REFERENCES

[1] A. K. Gautam and B. R. Vishvakarma, Frequency agile microstrip antenna, *Microwave Opt. Technology Letters* 49 (9), 431-434 (2007).

[2] W.C. Su and K. L. Wong, Internal PIFAS for UMTS/WLAN/WIMAX multi-network operation for a usb dongle, *Microwave and Optical Technology Letters* 48, 2149 215 (2006).

[3] J. S. R. C. Y. D. Sim and M. Ŷ. Chen, Characteristics of superstrate-loaded circular polarization square-ring microstrip antennas on thick substrate, *Microwave and Optical Technology Letters* 47, 567570, (2005).

[4] Y.T. C. Hong-Twu Chen, Full-wave analysis of a disk-loaded spherical annular-ring microstrip antennas, *Microwave and Optical Technology Letters* 12, 353-358 (1996).

[5] L. S. Saeed I. Latif, Investigation on probe-fed open-ring microstrip antenna for miniaturization, *Microwave and Optical Technology Letters* 48, 2175-2179 (2006).

[6] Q. W. F. Wang, Z. Du and K. Gong, Enhanced-bandwidth PIFA with t shaped ground plane, *Electronics Letters* 40, 1504 -1505 (2004).

[7] P. C. Sharma and K. C. Gupta, Analysis and optimised design of single feed circularly polarized microstrip antennas, *IEEE Trans. Antennas Propagation* 31, 949-955 (1983).

[8] IE3D, Zeland software co. (USA).

[9] C. K. W. We-Shyang Chen and K. L. Wong, Single-feed square ring microstrip antenna with truncated corners for compact circular polarization operation, *Electronics Letters (USA)* 34, 1045–1047 (1998).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799

JNPS
J.Nat. & Phys. Sc.

Vol. 24, No.1, pp.5-9 (2011)

Miniaturization of Microstrip Patch Antenna obtained by Patch Meandering and Shorting Pin Loading Technique

Janak Kapoor
Department of Electronics & Communication Engineering, M.J.P. Rohilkhand University, Bareilly (UP), India
(**Email**: Janak_kapoor@rediffmail.com)

ABSTRACT- Reduced size microstrip antennas with different slot and patch shapes are investigated. The ground plane size is 20 x 20 mm^2 and substrate is 1.6mm which is about the size of a typical wireless card. Detailed simulation and experimental investigations are conducted to understand their behavior and optimize for miniaturized operation. It has been shown that the shorting pin makes the patch resonate at a much lower frequency compared with the conventional patch of same size and the narrow slot increases the effective electrical length of the patch thus reducing the required disk size for an antenna operated at a given frequency and helps providing more space on ground plane for electronics. The CST simulation software is employed for optimizing the design parameters and the simulation results in general agree with the measured data. Radiation patterns, S-parameter for circular and square shaped meandered patch antennas for frequency band of 1100MHz to 3000MHz are measured and shown.

KEYWORDS: Mobile Communication, Microstrip patch antenna, circular patch, square patch, meandering, miniaturization.

1. INTRODUCTION

Mobile communication has become an important part of telecommunications [1]. Original applications such as paging, mobile phones, GPS have shown a tremendous growth and new applications are emerging every day: tagging, wireless computer links, wireless microphones, remote control, wireless multimedia links, satellite mobile phones, wireless internet just about everything "goes mobile". Mobile means practical for the user and easily transportable.

The mobile terminals of wireless applications networks must be light, small, have low energy consumption and have an appealing design. Technology has evolved very quickly to satisfy these needs in a rapidly growing market: chips are becoming smaller, they consume less current, they are more efficient and they perform more complex operations. Thus the sizes of the electronics needed for mobile application has decreased drastically during past few years, whereas their functionality has increased.

The antennas, however, have not experienced the same evolution, and marketing staff and designers are pressing engineers to develop smaller antennas. In opposition to electronic chips, the size of the antenna for a given application is not related mainly to the technology used, but is determined by the laws of physics: the antenna size with respect to the wavelength is the parameter that will have the preponderant influence on the radiation characteristics. This follows from the fact that an antenna is used to transform a guided wave into a radiated wave, and vice-versa, and one understands that to perform this transformation efficiently, the size should be of the order of half a wavelength or larger. Antennas can, of course, be made smaller, but at the expense of bandwidth, gain, and efficiency. The art of antenna miniaturization is an art of compromise: one has to design the smallest possible antenna that is still suitable for a given application with regard to its radiation characteristics, or in other words, one Looks for the best compromise between volume, bandwidth and efficiency and this best compromise is usually obtained when most of the allotted volume participates in the radiation. In order of antenna miniaturization several approaches have been proposed such as the length of a wall shorted rectangular patch antenna can be reduced from $\lambda_0/4$ to $\lambda_0/8$ by a simple folding operation [2], by slot loading

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

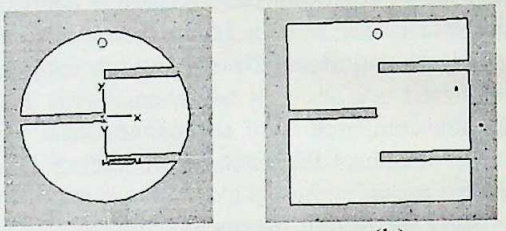
Digitized by Arya Samaj Foundation Chennai and eGangotri

technique [3], with the use of E-shaped parasitic shorting strips [4], by periodically loading the printed antennas with shunt capacitors to slow down the guided wave in the structures [5], miniaturization of rectangular microstrip patches based on genetic algorithms [6], antennas with different slot shapes-straight, L and inverted T, and placed on a small ground plane [7], by increasing the dielectric constant of the microwave substrate material, the addition of a shorting wall between the conducting patch and the ground plane, and the addition of a shorting pin between the conducting patch and the ground plane[8],using a shorted circular patch surrounded with non-planar rings [9].

In this paper, novel compact microstrip antennas with three different patch structures are presented. The first proposed design consists of a rectangular microstrip antenna with shorting pin and meandering narrow slots embedded in the antenna surface. The second proposed design consists of a square patch microstrip antenna with meandering slits and shorting pin.

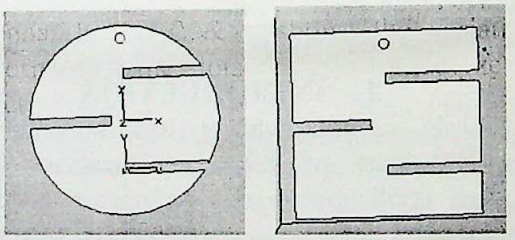
2. ANTENNA DESIGN

The design procedure for the proposed antenna is quite simple: fist of all, the total length of the meandered top patch and bottom patch is chosen to be about one-quarter wavelength of the resonant mode and then, by adjusting the length of the cut slot, the lowest resonant frequency is deduced. The geometry of the proposed antenna with a meandered circular patch is shown in figure 1(a) and square patch in figure 1(b). The meandered patch is printed on the supporting dielectric substrate of dielectric constant 4.4, dimensions 20 mm × 20 mm ×1.6 mm cylindrical pin of diameter 0.4 mm and length 1.6 mm is used for shorting the patch with the ground plane of PEC material having 20mm × 20mm, lowest possible thickness. The patch dimensions are taken to be 15mm × 15mm for the square patch and radius of 7.5 mm for the circular patch as shown in figure 1(a) & 1(b), the top patch is meandered by cutting three slits of width 0.8mm and length half the patch length in case of square patch, equal to radius in case of circular patch. Since these antennas are designed for analyzing the effect of meandering on the patch surface the slots of fixed width and variable length are as cut and the resultant effect on the resonant frequency as shown. A coaxial probe is used to feed the proposed antenna. Figure 2 & 3 shows the variations performed on the slots in order to analyze the effect of meandering.



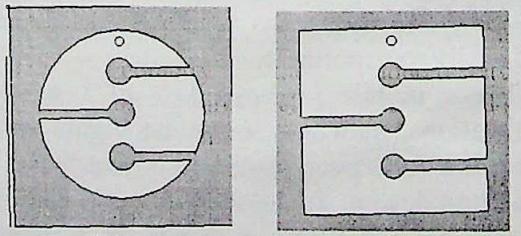
(a) (b)

Fig. 1: The geometry of the meandered circular patch and square patch antenna with all slots of equal length.



(a) (b)

Fig. 2: The geometry of the meandered circular patch and square patch antenna with center slot of decreased length.



(a) (b)

Fig. 3: The geometry of the meandered circular patch and square patch antenna with all slots of equal length and countered edges.

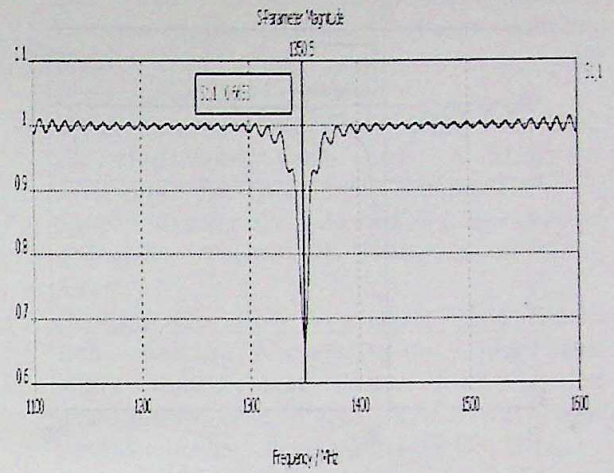
3. RESULTS AND DISCUSSION

The simulation software released by Computer Simulation Technology (CST), however, due to the software limitations there might be some minor disagreements between the simulation and measured results. Figure 4

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

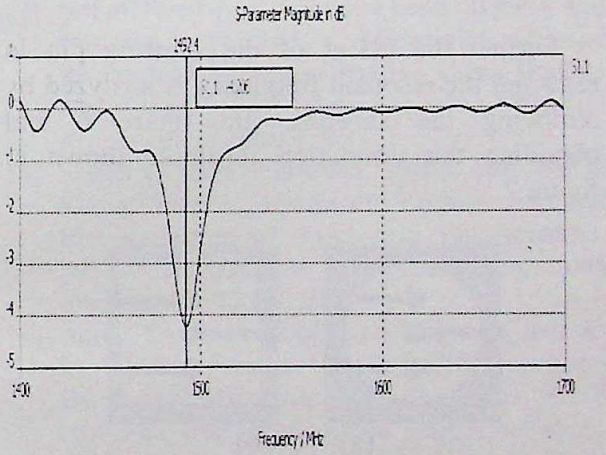
Digitized by Arya Samaj Foundation Chennai and eGangotri

shows the simulated S-parameter for the circular patch antenna with different slot length it can be seen that as the length of the central slot is equal to the radius the antenna resonates at 1639.2 MHz shown in figure 4(a) and as the length of the slot is decreased 2mm the resonant frequency increases to 1685.7MHz shown in figure 4(b) and further when the edges of the slots are contoured there length increases lowering the resonant frequency to 1350.5 MHz shown in figure 4(c) .Similarly Figure 5 shows the S-parameter for the square patch antenna and it can be seen that as the length of the central slot is equal to half the length of the patch edge the antenna resonates at 1492.4 MHz shown in figure 5(a) and as the length of the slot is decreased 2mm the resonant frequency increases to 1528.1 MHz shown in figure 5(b) and further when the edges of the slots are contoured there length increases lowering the resonant frequency to 1290.9 MHz shown in figure 5(c). It is thus found that, by increasing the slot length the resonant frequency has reduced and is found to be lowest in the proposed antenna with countered slots.

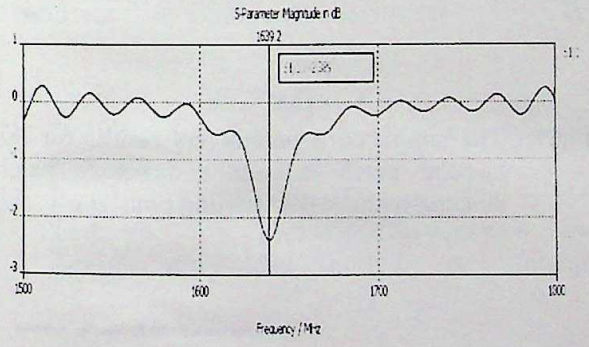


(c)

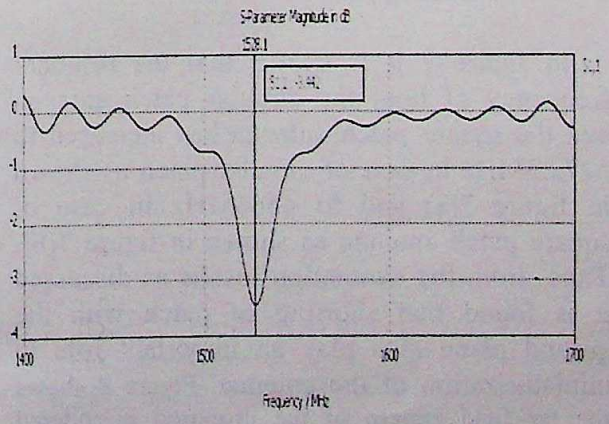
Fig .4: The simulated S-parameters results for the circular patch antenna with variable slot length.



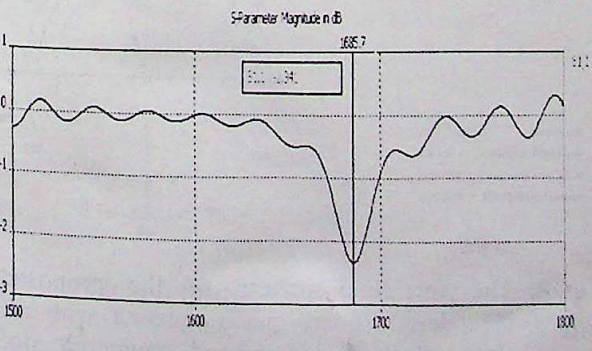
(a)



(a)



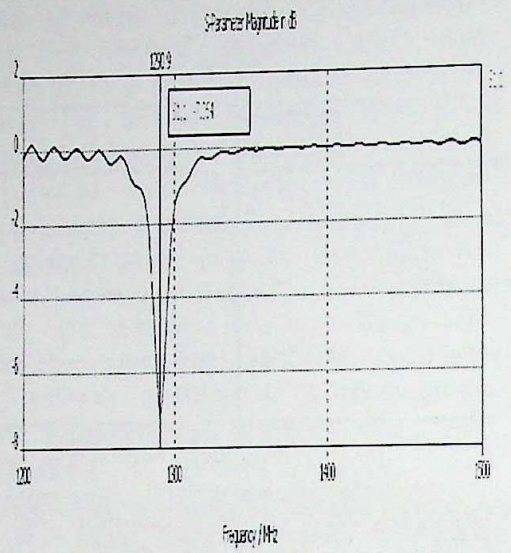
(b)



(b)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

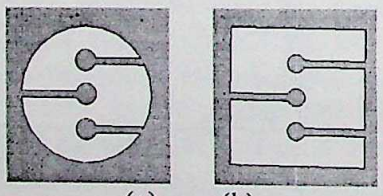
Digitized by Arya Samaj Foundation Chennai and eGangotri



(c)

Fig.5: The simulated S-parameters results for the square patch antenna with variable slot length.

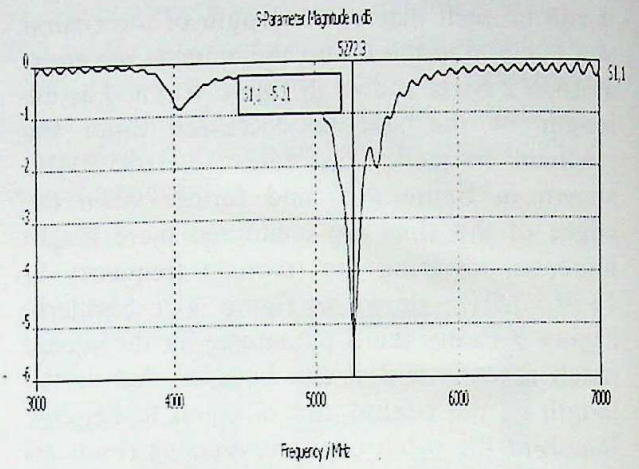
Further the effect of the shorting pin in reducing the resonant frequency is analyzed by removing the shorting pin figure 6 and obtaining the simulation result as shown in figure 7.



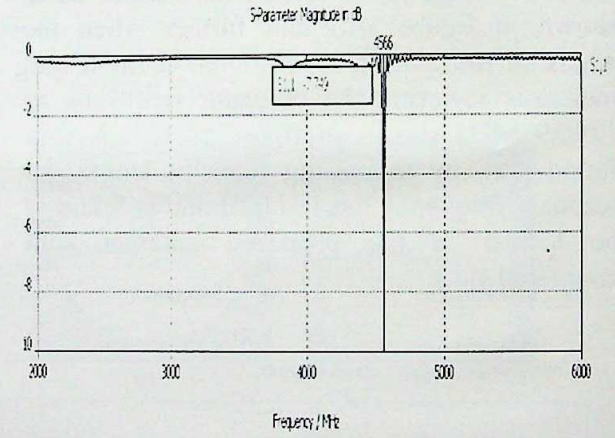
(a) (b)

Fig. 6: The geometry of the meandered circular patch and square patch antenna with all slots of equal length and countered edges without the shorting pins.

In figure 7 it is shown that the resonant frequency of both the circular patch antenna and the square patch antenna has increased to 5272.3MHz in case of circular patch as shown in figure 7(a) and to 4566MHz in case of square patch antenna as shown in figure 7(b). Thus from the simulation results as discussed it is found that shorting of patch with the ground plane also play an important role in miniaturization of the antenna. Figure 8 shows the far field pattern of the proposed meandered square patch antenna with all slots of equal length and countered slot edges.



(a)



(b)

Fig.7: The simulated S-parameters results for the circular patch antenna and square patch antenna without the shorting pin.

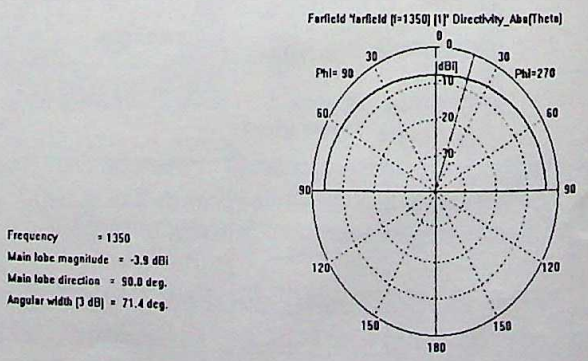


Fig. 8: The far field pattern of the proposed meandered square patch antenna with all slots of equal length and countered slot edges.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

4. CONCLUSION

In this paper, we present a novel method of miniaturization for designing the ultra low-profile patch antenna. Commercial software CST has been used to simulate the antenna characteristics. The designed results demonstrate that the compact structure properties are achieved by using shorting pin and meandered slots, A square and a circular shorted patch antenna with a meandered slots contoured at the end has been proposed and studied. It has been demonstrated that, with the radiating patch been meandered and shorted, the excitation of 1290.9 MHz (for square patch) and 1350.5 MHz (for circular patch) resonant frequency can be achieved. In addition, the proposed antenna occupies a small volume of 20 x 20 x 1.6 mm^3, which makes it very attractive for the application as an internal mobile phone antenna. Good radiation characteristics for the two operating frequencies have also been observed.

5. ACKNOWLEDGEMENT

The author thanks Mr. Vipul Sharma, Department of Electronics & Communication Engineering, Faculty of Engineering & Technology, Gurukul Kangri University, Haridwar for valuable discussions.

REFRENCES

[1] Compact and Broadband Microstrip Antenna by Kin-Lu-Wong, Edition 2002.

[2] RongLin Li, Gerald DeJean, Manos M. Tentzeris, Joy Laskar., Development and Analysis of a Folded Shorted- Patch Antenna With Reduced Size, *IEEE Transactions on Antennas and Propagation* 52 (2), 2004.

[3] Shaoqiu Xiao, Bing-Zhong Wang, Wei Shao, and Yan Zhang., Bandwidth-Enhancing Ultralow-Profile Compact Patch Antenna, *IEEE Transactions on Antennas and Propagation* 53 (11), 2005.

[4] Kwok Kan So, Hang Wong, Kwai Man Luk, Chi Hou Chan, Quan Xue., A Miniature Circularly Polarization Patch Antenna Using E-Shaped Shorting Strip, *State Key Laboratory of Millimeter Waves City University of Hong Kong.*

[5] Pei-Ling Chi, Rod Waterhouse and Tatsuo Itoh., Antenna Miniaturization Using Slow Wave Enhancement Factor from Loaded Transmission Line Models, *IEEE Transactions on Antennas and Propagation* 59 (1), 2011.

[6] Rashid Ahmad Bhatti, Ngoc-Anh Nguyen, Viet-Anh Nguyen and Seong ook Park., Design of a Compact Internal Antenna for Multi-Band Personal Communication Handsets, *Proceedings of Asia-Pacific Microwave Conference*, 2007.

[7] Naftali Herscovici, Manuel Fuentes Osorio, and Custódio Peixeiro., Miniaturization of Rectangular Microstrip Patches Using Genetic Algorithms, *IEEE Antennas And Wireless Propagation Letters* 1, 2002.

[8] Saeed I. Latif, Lotfollah Shafai, and Satish Kumar Sharma., Bandwidth Enhancement and Size Reduction of Microstrip Slot Antennas, *IEEE Transactions on Antennas and Propagation* 53 (3), 2005.

[9] Aaron K. Shackelford, Kai-Fong Lee, and K. M. Luk., Design of Small-Size Wide-Bandwidth Microstrip-Patch Antennas, *IEEE Antennas and Propogotion Magazine* 45(1), 2003.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri
Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.11-16 (2011)

Comparison of Key Players of Cloud Computing on the Basis of Service Models

G.D. Makkar[1], Meenakshi Bist[1] and Amit Agarwal[2]

[1]*Dept. of Computer Science, S.G.R.R. Institute of Technology & Sciences, Dehradun, India*
[2]*Dept. of Computer Science & Engineering, College of Engineering Roorkee, Roorkee, India*

ABSTRACT- A large number of organizations does not want to spend money on deploying heavy resources; they want that someone could provide resources to them on rent as they find its much cheaper then deploying it. For these companies Clouds are the best option in which organization need not maintain their own infrastructure, resources and to purchase any expensive software. They can rent the service as per their business needs. Cloud computing is just to provide various services like Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a service (IaaS) and many more on rent to users or organizations on basis of pay as per use on virtual world Internet. Today cloud computing is counted in top ten best technologies. With the growth of many Cloud providers, identification of the best cloud that fits the business needs of an organization is a difficult task. Even with some knowledge of cloud computing, it is still hard for any user to select a cloud and make reasonable choice. Detailed study of number of parameters is required before selecting a cloud provider. In this paper we discussed about differences in various services provided by three cloud providers companies i.e., Google, Amazon and Microsoft. On the basis of comparison of these services, user can easily understand the cloud computing and services provided by it and make appropriate choice.

KEYWORDS: Cloud Computing, SaaS, PaaS, IaaS, NIST, Salesforce, Rackspace, GoGrid.

1. INTRODUCTION

Cloud Computing is defined as an Internet-based computing, where there is a large group of interconnected computers or Cloud that share their resources, software, and information (computing), on demand, according to the user needs [1]. The National Institute of Standards and Technology (NIST) [2] characterizes cloud computing as pay-per-use model for enabling available, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Cloud computing is a new technology spreading widely in recent years. On demand self-service enables users to use cloud computing resources without human interaction between the user and the cloud service provider. With on demand self-service, a consumer can use any cloud services such as computation and storage as needed.

The self-service interface must be user-friendly in order to make cloud service more effective and manageable. This ease of use and elimination of human interaction provides efficiencies and cost savings to both the user and the cloud service provider. There are many cloud service providers in world, some of the widely used are of Microsoft, Google and Amazon. Figure 1 shows the architecture of cloud computing.

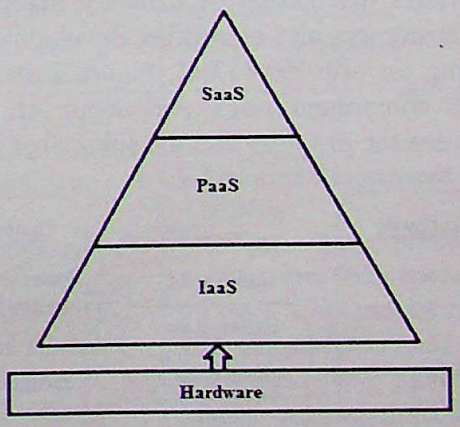


Fig. 1: Architecture of Cloud Computing.

2. SERVICE MODELS

Service models are the different type of services that the service provider provides to the users through their cloud. The most common services are Software as a Service, Platform as a Service, and Infrastructure as a

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Service also known as SPI model. Other services providing are Hardware as a Service (HaaS), Development, Database, Desktop as a Service (DaaS), Framework as a Service (FaaS), Business as a Service (BaaS) and Organization as a Service (OaaS).

2.1 Software as a Service

Software-as-a-Service (SaaS) is a software distribution and deployment model in which applications are provided to customers as a service. It is based on using licensed software and application on demand, which is already installed and running on a cloud platform. These on-demand applications may have been developed and deployed on the PaaS or IaaS layer of a cloud platform. SaaS replaces the use of software from traditional to rent model, thus reducing the user's physical equipment deployment and management costs. Since all the applications are kept online and are accessed through a web browser, users can access their accounts from any internet-connected computer, and there is no need to install anything extra locally. The SaaS clouds may also allow users to develop own applications to meet their requirements. SaaS comes on top of the cloud stack. The primary SaaS cloud service providers are GoogleApps, SalesForce.com, Desktop as a service etc. It alleviates the burden of software maintenance for customers and simplifies development and testing for providers [3,4]. Figure 2 shows the SaaS component stack and scope of control between the provider and the subscriber [5].

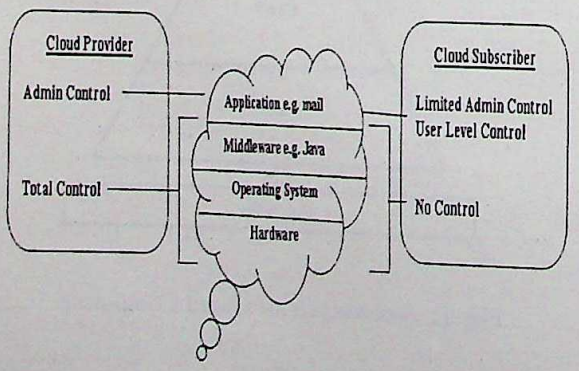


Fig 2: SaaS Component stack and extent/range of control

Table 1 shows the comparison of significant features offered by key public cloud providers of the industry for SaaS.

2.2 Platform as a Service

PaaS offers entire application development environment. It is basically used by application developers, testers and administrators to develop and testing software's. Entire life cycie of software can be operated on a PaaS. PaaS solutions differ from SaaS solutions in the way that PaaS provide software development environment while SaaS provide applications to use. PaaS solution Providers deliver both the computing platform and the solution stack. This greatly accelerates development and deployment of software applications. Using the concept of PaaS, software developers can build Web applications without having to install the software building tools on their own computer, and then distribute or deploy their apps to the cloud easily. PaaS encapsulates a layer of software and provides it as a service that can be used to build higher-level services.

PaaS (Platform as a Service) provides virtual machines, operating systems, applications, services, development frameworks, transactions, and control structures. The key players in cloud computing that mainly offers PaaS are Force.com, GoGrid CloudCenter, Google AppEngine, Windows Azure Platform. Figure 3 shows PaaS Component Stack and Scope of Control as between the provider and the subscriber [5].

Table 2 shows the comparison of significant features offered by key public cloud providers of the industry for PaaS.

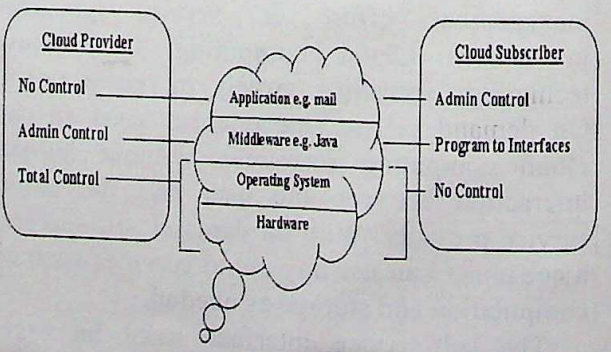


Fig 3: PaaS Component stack and extent/range of control

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

2.3 Infrastructure as a Service

IaaS offer computing and storage capability on demand. Though, the difference between IaaS and above two is that IaaS vendors deploy virtualization technologies to provide the compute power. In case of PaaS you can deploy the application. But with IaaS you can create a virtual machine that offers the things required to run your application rather than being restricted to a certain development environment. You can have your choice of an OS image, development environment and host it on the IaaS vendor infrastructure. With the IaaS, you get virtual computers, cloud storage, network infrastructure components such as firewalls and configuration services. The main users of this service are system administrators. Usage fees are calculated per CPU hour, data GB stored per hour, network bandwidth consumed, network infrastructure used per hour, value added services used, e.g., monitoring, auto-scaling etc. The figure 4 shows IaaS Component Stack and Scope of Control as between the provider and the subscriber [5].

Table 3 shows the comparison of significant features offered by key public cloud providers of the industry for IaaS.

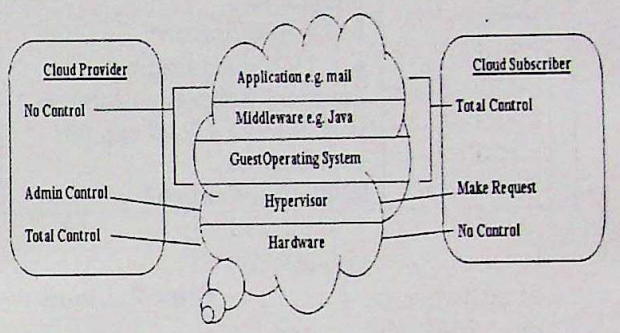


Fig 4: IaaS Component stack and extent/range of control

Table 1: Comparison of significant features for SaaS

	Saleforce [6]	Google Apps [7]	Microsoft SQL Azure [8]
Service or Products Provided	Saleforce Customer Relationship Management	Gmail for business, Google Groups, Google Calendar, Google Talk, Google Docs , Google Video and Google Sites.	Sql azure database. Sql azure reporting. Sql azure data sync.
Benefits	• Optimized runtime processing • Optimized storage • Predictable load balancing • Continual analysis and energy improvement • Energy efficient servers • Micro-energy management • Optimized power consumption • Standardized multi- tenent architecture	• Administrator can handle multiple domains with a single account. • By default Google Apps uses HTTPS. Google App is protected by Postini Anti-virus services, spam filtering, disaster recovery, and a 99.9% uptime SLA.	• Unlimited, automated scaling. Self managing, self healing • Automatic failover. • Low friction provisioning • Pay as you consume • Business Ready SLA. • Multi-tenent architecture.
Architecture	Multitenent Architecture	• Map Reduce Architecture • Google File System Architecture(GFS)	Four layer archi-tecture comprising of client, service, platform, and infrastructure layers
Limitations	There is an online storage limit of 1GB or 120/MB per user for the unlimited plan. Salesforce requires an online	• 500 messages per day • 500 unique recipients per message 2000 total emails per day	• Maximum database size 50GB. • File groups are not supported.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	connection to work, and offline access is only available in the more expensive editions.	• Allows any number of users.	• Puts a limit on the number of users
Pricing	• Professional Edition Basic service and support for any size team $65 /user/month* • Enterprise Edition Extend service to the Web with customization and integration $135 /user/month* • Unlimited Edition Premier+ Support customizes your Service Cloud app for your business $260 /user/month*	• Google Apps is free and offers the same amount of storage as regular Gmail accounts. • Google Apps for Business offers additional e-mail storage, is available for an annual fee per user account. • Google Apps for Education, which is free, combines features from the Standard and Premier editions.	You pay based on the total number of databases that existed at any point during a particular day.

Table 2: Comparison of significant features for PaaS

	Force.com [6]	Google App Engine [7]	Microsoft Azure [8]
Platform Supported	**Software:** • Unlimited real-time database customizations • Programmable user interface • Programmable cloud logic • Real-time workflow and approvals • Real-time web sites • Real-time mobile deployment • Integrated content library • Real-time analytics • Granular security and sharing	**Runtime:** • Java Runtime Environment. • Python Runtime Environment. • APIs to access Google services. **Software** External software like AppServers Databases cannot be installed.	**Operating Systems:** • Windows 7 • Windows Server 2008 • Windows Vista
Storage format used	Pivot tables	Bigtable	BLOBs, tables, and queues
Cloud services and tools	• Apex Language Code Editor • Enhanced Metadata Support • Upgrade Wizar	• Google Secure Data Connector. • Private gadgets. • Google visualization API. • Google Apps APIs • Google web toolkit. • IDE support.	• Windows Azure Platform Training Kit • Windows Azure Software Development Kit • Microsoft Visual Studio 2008 Service Pack 1 • Windows Azure platform AppFabric SDK V1.0 • Windows 7 Training Kit For Developers
Infrastructure Used	Saleforce Data Center	Google Data Center	Microsoft Data Centers (Virtual Machine Based)
Hosted Applications	• EA • Author Solutions • The Wall Street Journal	• Socialwok • Gigapan • LingoSpot	Microsoft Pinpoint
Data Backup	• All networking components, SSL accelerators, load	• The user is solely responsible for securing and backing up the	The user is solely responsible for securing and backing up the data.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	balancers, Web servers, and application servers are configured in a redundant configuration. • All customer data is stored on a primary database server that is clustered with a backup database server for redundancy • All customer data is stored on disk storage that is mirrored across different storage cabinets and controllers • All customer data, up to the last committed transaction, is automatically backed up to a primary tape library on a nightly basis • Backup tapes are immediately cloned to a second tape library to verify their integrity, and the clones are moved to secure, fire-resistant, off-site storage on a regular basis.	Application for any Content. • Google has no responsibility or liability for the deletion or failure of any Content and other communications maintained or transmitted through use of the Service.	
Languages Supported	Apex , Java, VB.Net, Perl, PHP, Python, Ruby, Windows language, including VBA, s-controls and AJAX	Java, Python	VB.NET C# PHP
Pricing	Different prices for Force.com , Force.com Enterprise, and Force.com Unlimited	Billing is based on the following parameters • Outgoing Bandwidth • Incoming Bandwidth .CPU Time. • CPU Stored Data. • Recipients Emailed.	Billing is based on • Compute • Storage • Storage transactions Data transfers.

Table 3: Comparison of significant features for IaaS

	Amazon EC2 [9]	**Rackspace [10]**	**GoGrid [11]**
Virtualization	• **Xen**, a virtual-machine monitor. It allows multiple computer operating systems to execute on the same computer hardware concurrently. • It uses Xen as the VM hypervisor. • Xen hypervisor is used to manage their Amazon Machine Image (AMI) instance.	Uses Xen as the VM hypervisor	Vmware
Load Balancer	• Elastic Load Balancing (ELB) • It uses round robin load balancing	• Cloud Load Balancer • It is on Zeus' load balancing technology	• F5 load balancing • It is based on BIG-IP load balancing technology
Server RAM	1.7 GB and going up	256 MB and going upto	0.5 GB and going up

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	to 68.4 GB	16 GB	To 8 GB
OS support	• Linux (Red hat Enterprise, Oracle Enterprise, SUSE Enterprise, Ubuntu, Fedora Gentoo) • Windows Server • Amazon linux AMI, Debian	• Linux • Mac OS X • Windows	• Windows server 2003/2008 • CentOS 5.1/5.3 • Redhat Linux 5.1/5.4
Persistent Block Storage	Yes	No	Yes.
Hybrid Hosting	No	Yes	Yes
Pricing Model & Basic computing unit	'pay as you go' pricing model The basic unit of Amazon EC2 is On Demand Instances. • Small Instance (default): 1.7GB of RAM, 1 CPU Core, 160GB of Storage, 32-bit platforms only $0.085/hour for Small • Large Instance: 7.5GB of RAM, 2 virtual cores, 850GB of Storage, 64-bit platforms (and 32-bit if you wish) $0.34/hour for Large • Extra Large Instance: 15GB of RAM, 4 virtual cores, 1.7TB of Storage, 64-bit platforms (and 32-bit if you wish) $0.68/hour for Extra Large • Amazon EC2 also can provide High-Memory, High-CPU, and Cluster capable Instances	'Pay As You Go' pricing model Rackspace Cloud Servers are Windows Images with RAM, Disk and Network Throughput. • 256MB RAM, 10 GB Disk: $0.015/hour • 512MB RAM, 20 GB Disk: $0.03/hour • 1024MB RAM, 40GB Disk: $0.06/hour • 2048MB RAM, 80GB Disk: $0.12/hour • 4096MB RAM, 160GB Disk: $0.24/hour • 8192MB RAM, 320GB Disk: $0.48/hour	'Pay As You Go' pricing model The basic computing unit of Gogrid is RAM Hour. • Billed $0.19 per GB of deployed RAM per hour and 60 GB of disk, $0.50 per GB of outbound data transferred • With GoGrid, all inbound transfer is free.

3. CONCLUSION

Cloud computing is a new technology widely studied in recent years. Now there are many cloud providers available in the world. Comparison based on the services provided (SaaS, PaaS, and IaaS) by some key players has been presented in this paper. From the analysis and summarization, users can better understand the characteristics and better choose the cloud computing service according to their requirement. Each cloud computing services has its own strength, and every key provider is enhancing their services, platform, infrastructure and security day by day and trying to include and offer more services on their cloud. One day will come when these cloud providers might provide tailor made services to the users.

REFERENCES

[1] L.M. Vaquero, L. Rodero-Merino, J. Caceres and M. Lindner, A break in the clouds: towards a cloud definition, *ACM SIGCOMM Comput. Comm. Rev.* 39(1), 50-55 (2009).

[2] P. Mell, and T. Grance, The NIST Definition of Cloud Computing, National Institute of Standards and Technology, Information Technology Laboratory, *Technical Report*, 15 2009.

[3] Inc. Appistry, Cloud Platforms vs. Cloud Infrastructure, *White Paper*, 2009.

[4] B. Hayes, Cloud computing, *Communications of the ACM* 51, 9-11 (2008).

[5] www.nist.gov

[6] www.salesforce.com

[7] www.google.com/apps

[8] http://www.microsoft.com/windowsazure

[9] http://www.amazon.com/

[10] www.rackspace.com/cloud

[11] www.gogrid.com

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.17-20 (2011)

Filtered-X Affine Projection Algorithm in Active Noise Control

Manikant Kumar[1#], Modm. Farman[2] and Vivek Kumar[3]
[1]*Techwords (W.G.V.S), Manglour,Roorkee, India*
[2]*R.I.T., Puhana, Roorke, India*
[3]*Gurukula Kangri Vishwavidyalaya, Haridwar, India*
[#]Corresponding author (**Email**: manikantmit2k3@gmail.com)

ABSTRACT- Active noise controllers (ANC) are based on the destructive interference in a given location of the noise produced by some primary source with an interfacing signal generated by some secondary source with an adaptive controller. A commonly used strategy is based on the feed forward and feedback method, where some reference signals measured in the proximity of the noise source are available. Filtered-X AP algorithm used for high frequency and multi channel, decreased sensitivity to error in the error/path model. Feed forward system has given better performance than feedback methods for filtered- AP algorithm.

KEYWORDS: ANC, AP Algorithm, Feed forward system, Feedback system.

1. INTRODUCTION

The affine projection algorithms are a family of adaptive filters that can produce a good trade-off between convergence speed and computational complexity. Their properties have been exploited for many years in the field of acoustic echo cancellation and recently it was recognized that the filtered- AP algorithm can be very helpful also in the field of active noise control both for single channel and multichannel solutions [1].

Every system has time-varying or certain parameters of the system. This parameter can be linear or nonlinear. We adapt the filtering technique to track the dynamics of the system or learn the unknown parameters. Nonlinear effect has been reduced by certain Algorithm. Nonlinear models are usually far more complex and computational expansive than linear model. However, digital signal processing (DSP) are becoming much faster and specialized, so that in the future the implementation of nonlinear model will not cause major problem. For these reason, it is beneficial to investigate the capabilities of nonlinear models to model or to predict nonlinear determination noise. It is very likely that nonlinear models will overcome a variety of problem which encounters in linear filtering techniques [2].

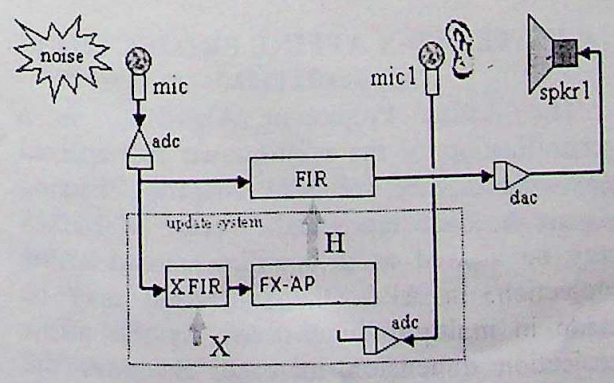


Fig.1: Block diagram of ANC

2. STRUCTURE OF ANC

Two major types of active noise control system is considered as Adaptive Feed-forward ANC and Feedback ANC. Both time domain and frequency domain is considered in feed-forward adaptive filtering system and the time domain is considered in the feedback system. Feedback control systems differ from feed-forward systems in the manner in which the control signal is derived. Whereas feed-forward systems rely on some predictive measure of the incoming disturbance to generate an appropriate "cancelling" disturbance, feedback systems aim to attenuate the residual effects of the disturbance after it has passed [3]. Feedback systems are thus better at reducing the transient response of systems, while feed-forward systems are better at reducing the steady state response. Because of their inherent stability, feed-forward controllers are generally preferred over feedback controllers when a reference signal, which is correlated with the error signal, is available. This arrangement

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

minimizes cost and maximizes performance [4].

3. VOLTERRA SERIES REPRESENTATION

A linear, causal system with memory can be described by the convolution representation

$$Y(t) = \int_{-\infty}^{\infty} h(\sigma)x(t-\sigma) \qquad (1)$$

Where x(t) is the input, y(t) the output, and h(t) the impulse response of the system. A nonlinear system without memory can be described with a Taylor series

$$Y(t) = \sum_{n=1}^{\infty} a_n[x(t)]^n \qquad (2)$$

Where x(t) is the input , y(t) the output and a_n are the Tayler series coefficient.

A Volterra series combines the above two representations to describe a nonlinear system with memory .

$$Y(t) = \sum_{n=1}^{\infty} \frac{1}{n!} \int_{-\infty}^{\infty} du_1 \ldots \int_{-\infty}^{\infty} du_n g_n(u_1, \ldots u_n) \prod_{r=1}^{n} x(tu_r) \qquad (3)$$

$$= \frac{1}{1!} \int_{-\infty}^{\infty} du_1 g_1(u_1)x(t-u_1) + \frac{1}{2!} \int_{-\infty}^{\infty} du_1 \int_{-\infty}^{\infty} du_2 g_2(u_1,u_2)x(t-u_1)x(t-u_2) + \frac{1}{3!} \int_{-\infty}^{\infty} du_1 \int_{-\infty}^{\infty} du_2 \int_{-\infty}^{\infty} du_3 g_3(u_1,u_2,u_3)x(t-u_1)x(t-u_2) x(t-u_3) + \ldots\ldots\ldots \qquad (4)$$

X(t) is the input, y(t) is the output, and the $g_n(u_1, \ldots\ldots\ldots u_n)$ are called the Volterra kernels of the system or simply the kernel. The u_i are time variables and are labeled u_i instead of t_i to distinguish them better from t. For n=1, $g_1(u_1)$ will be recognized as the familiar impulse response h(t) in Eq. (1); thus, g_n for n>1 are rather like "higher-order impulse responses." These serve to characterize the various orders of nonlinearity. The first few terms of Eq.(3) have been explicitly written out; Eq.(4) is the familiar convolution integral. Eq.(3) is an infinite sum of n-fold convolution integrals [4].

Just as Eq.(3) is analogous to n-fold convolution, there exist n-fold analogies to Laplace and Fourier transforms. These are defined by

$$G_n(f_1, \ldots\ldots\ldots, f_n) = \int_{-\infty}^{\infty} du_1 \int_{-\infty}^{\infty} du_n g_n(u_1, \ldots\ldots\ldots, u_n) e^{-s_1 u_1} \ldots\ldots e^{-s_n u_n} \qquad (5)$$

and

$$G_n(f_1, \ldots\ldots\ldots, f_n) = \int_{-\infty}^{\infty} du_1 \ldots\ldots \int_{-\infty}^{\infty} du_n g_n(u_1, \ldots\ldots, u_n) e^{-jw_1 u_1} \ldots\ldots e^{-jw_n u_n} \qquad (6)$$

where $w_i = 2\pi f_i$. It is clear that $G_1(s_1)$ is the familiar linear transfer function, and thus G_n in general is referred to as the n^{th}-order transfer function. These frequency domain representations G_n are useful because often they are much simpler to calculate than the sometimes prohibitively-complex time-domain representations g_n and because radio problems are often approached in the frequency domain. From the definitions (5) and (6), it follows that if $G_n(u_1, \ldots\ldots\ldots u_n)$ is a symmetric function of the u_{iu} then $G_n(f_1, \ldots\ldots\ldots f_n)$ is a symmetric function of the f_i The traditional frequency-domain input-output representation now becomes

$$Y(f) = \frac{1}{1!} G_1(f)X(f) + \frac{1}{2!} \int_{-\infty}^{\infty} df_1 G_2(f_1, f-f_2) + \frac{1}{3!} \int_{-\infty}^{\infty} df_2 G_3(f_1, f_2, f-f_2)X(f_1)X(f_2)X(f-f_1-f_2) + \ldots\ldots\ldots\ldots \qquad (7)$$

4. FILTERED-X AFFINE PROJECTION ALGORITHM

The Affine Projection Algorithm is a generalization of the well-known Normalized least-mean-square (NLMS) adaptive filtering algorithm. Each tap weight vector of NLMS may be viewed as a one-dimensional affine projection. In APA, the projection may be made in multiple dimensions. As the affine projection dimension increase, So does the convergence speed of tap weight vector and

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

unfortunately, the algorithm's computational complexity [5].

The error signal now takes different form

$e(n) = d(n) - U^T(n)w(n)$ (8)

Where

$d(n) = [d(n)\ d(n-1)\ d(n-2).....(n-N+1)]^T$

$X(n) = [x(n)\ x(n-1).....x(n-N+1)]^T$

$U(n) = [\ u(\ n\ ),\ u(\ n-1\ ),.....,\ u\ (\ n-\ L+1)\ ]^T$

These are desired response vector and input sample matrix, respectively. The dimension of the matrix X(n) is M×I is usually much smaller than the number of filter coefficient M, especially in the case of filter. The weight adjustment equation in APA is

$W(n+1) = w(n) + \mu U(n)g(n)$ (9)

Where g(n) is the pre-whitened error signal

$g(n) = [U^T(n)U(n) + \delta I]^{-1}e(n)$

estimation, L. This is advantage because usually I is much smaller than L.

Numerical solution of APA

The APA is an adaptive FIR filter [18]. An adaptive filter attempt to predict the most recent output, [d(n) , d(n-1) ,....., d(n-N+1)] of an unknown system, W_{sys} , from the most recent system input, [u(n) , u(n-1) ,....., u(n-L+N+1)] and the previous system estimate, w(n-1).U(n) is excitation signal and n is the time index [6].

$U(n) = [u(\ n\ ),\ u(\ n-1\ ),.....,\ u\ (\ n-\ L+1)]$ (10)

L is length excitation or tap-delay line vector.

$\alpha\ (n) = [\ u(n)\ ,\ u(n-1)\ ,.....,\ u(\ n-N+1)\ ]^T$ (11)

N is length excitation matrix.

$$U(n) = [u(n), u(n-1), ..., u(n-L+1)]^T = \begin{bmatrix} \alpha(n)^T \\ \vdots \\ \vdots \\ \alpha(n-L+1)^T \end{bmatrix}$$

L by N excitation matrix

$W(n) = [w_0(n),\ w_1(n),.....,\ w_{L-1}(n)]^T$ (12)

L length adaptive coefficient vector where $w_i(n)$ is i^{th} adaptive tap weight or coefficient at time n

$W_{sys} = [w_{0,sys}, w_{1sys}, ..., w_{L-1,sys}]^T$ (13)

L length system impulse response vector where $w_{i,sys}$ is i^{th} tap weight or coefficient.

Y(n) is measurement noise signal .

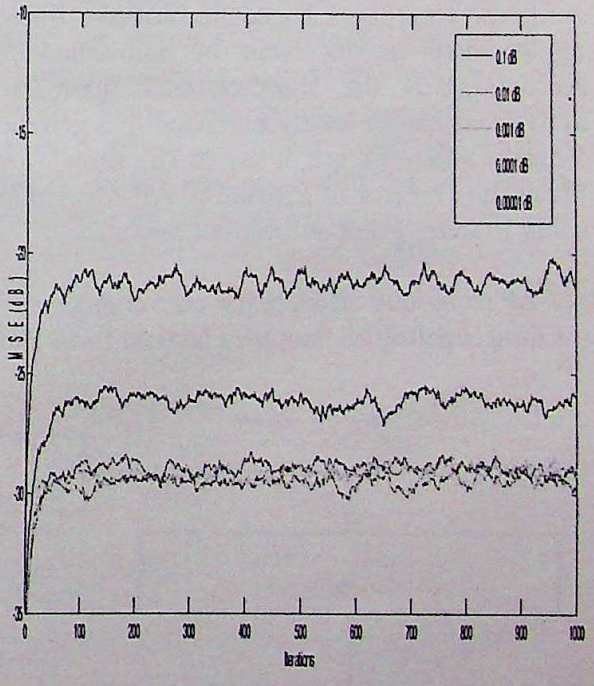
$Y(n) = [y(n), y(n-1), ..., y(n-N+1)]^T$ (14)

N is length noise signal vector.

5. SIMULATION RESULTS AND CONCLUSION

The convergence and tracking performance of LMS, Filtered-x LMS AP Algorithm are analyzed and compared for active noise control under time varying environment and varying order. From the simulation, following results are observed for the active noise control [7].

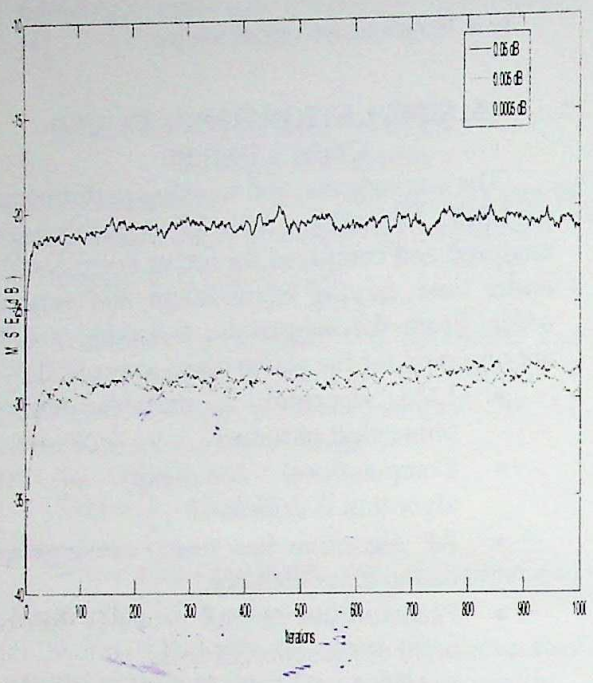
- LMS algorithm is unstable due to phase shift introduce.
- Computational complexity of AP algorithm is decreased.
- AP algorithm has faster convergence due to it has memory.
- Feed-forward control provides 3db or more of reduction in noise.
- Feedback controller provides over 10 db reductions in noise.
- For order L = 1, AP Algorithm is same as Filtered –x LMS algorithm.
- For order L = 2, input signal is speech signal for the faster convergence of filter.



(a)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri



(b)

Fig.2: Mean square error of filtered–X AP Algorithm.

Algorithms for active noise control deal with nonlinear effects. In such environments, nonlinear controllers based on Volterra filters implemented in the form of multi-channel. According to the multi-channel approach, derivations can be easily extended to a generic Volterra filter. Figure 2 (a) & (b) shows the Mean square Error of Filtered-X AP Algorithm using Volterra Filter at different step size.

AP technique offers better convergence and tracking capabilities than the classical LMS and NLMS algorithms with a limited increase of the computational complexity [8].

Another area of possible research work is the development of "fast" algorithms based on the Wiener model and higher Order Volterra filter. Wiener model and Volterra filter can be explored further to reduce the computational complexity and number of iterations.

REFERENCES

[1] P. Lueg, Process of Silencing Sound Oscillations, *U.S. Patent* No.2, 043 (416), 1936.

[2] H. F. Olsen and E. G. May, Electronic Sound Absorber, *J. Acoust. Soc. Am* 25, 1130-1136 (1953).

[3] Colin H. Hansen, Active noise Cancellation, *Taylor & Francies e-library,* 2003.

[4] Tokunbo Ogunfunmi, Adaptive Nonlinear System Identification: Santa Clara University Santa Clara, CA USA, *Springer Science & Business Media, LLC,* 2007.

[5] Alberto Carini, and Giovanni L. Sicuranza, Transient and Steady-State Analysis of Filtered- X Affine Projection Algorithms, *IEEE Trans. Speech Audio Processing* 54(2), 2006.

[6] Giovanni L. Sicuranza, Filtered-X Affine Projection Algorithm for Multichannel Active Noise Control Using Second-Order Volterra Filters, *IEEE Speech signal Processing,* 11(11), 2004.

[7] S. C. Douglas, Fast implementations of the filtered-X LMS and LMS algorithms For multichannel active noise control, *IEEE Trans. Speech Audio Processing* 7, 454-465 (1999).

[8] M. H. Costa, J. C. Bermudez, and N. J. Bershad, Stochastic analysis of the filtered-X LMS algorithm in systems with nonlinear secondary paths, *IEEE Trans. Signal Processing* 50 (6), 1327-1342 (2002).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.21-28 (2011)

A Survey on Slip Power Recovery Drives

Nikhil Mishra, Ankit Dixit, S.M. Tripathi and K.S.Verma
Dept. of Electrical Engineering, Kamla Nehru Institute of Technology, Sultanpur (U.P.) India

ABSTRACT- The use of a variable speed electric drive for speed control application usually offers an energy efficient and environment friendly solution. Speed control of the drive can be achieved by a number of means such as direct torque control, field-oriented control, and slip power recovery scheme. Generally, industrial applications require a precise and reliable variable-speed drive capable of giving long term stability and good transient performance. Slip power recovery scheme (SPRS) gains importance as it recovers that power which is normally wasted in the rotor. It also provides wide speed range and offers greater flexibility and control. Various schemes such as static Kramer's drive and static Scherbius' drive for slip power recovery and new innovations to improve the performance of the same have been surveyed in this paper.

KEYWORDS: Kramer's drive, Scherbius' drive, Slip power recovery.

132182

1. INTRODUCTION

With industrial perspective, various variable speed drive schemes are put into practice involving pulse width modulated VSI and CSI. PWM inverter drives are available for the applications where the speed control accuracy is not critical. The voltage source inverter drive displays its regeneration capability only along with back to back converter. The current source inverter drive suffers from cogging below 10% of its rated speed [1].

Unlike PWM inverter drives, the slip energy recovery drive transfers power that is normally wasted in the rotor of an induction machine back to the AC mains to improve overall drive efficiency [2]. The slip power becomes easily available from the slip-ring in wound rotor induction motor (WRIM), which can be either mechanically or electronically controlled for motor speed adjustments. Generally the controlling of the motor is obtained with the help of variation in applied voltage or introduction of external resistors either in stator or rotor windings [3]. But with the transition in industrial requirements, the need of high efficient slip energy drive arises [4]-[5].

Slip power recovery drive have been used in applications such as variable speed wind energy systems, shipboard, variable speed systems and utility system flywheel energy storage systems. By reducing the inverter firing angle, the power factor can be reduced which results in extracting less real power to the mains. Thus, slip power recovery system provides lower operating costs by slashing energy bills, enhanced life of mechanical equipment by reducing vibrations and efficient process control with speed holding accuracy [6].

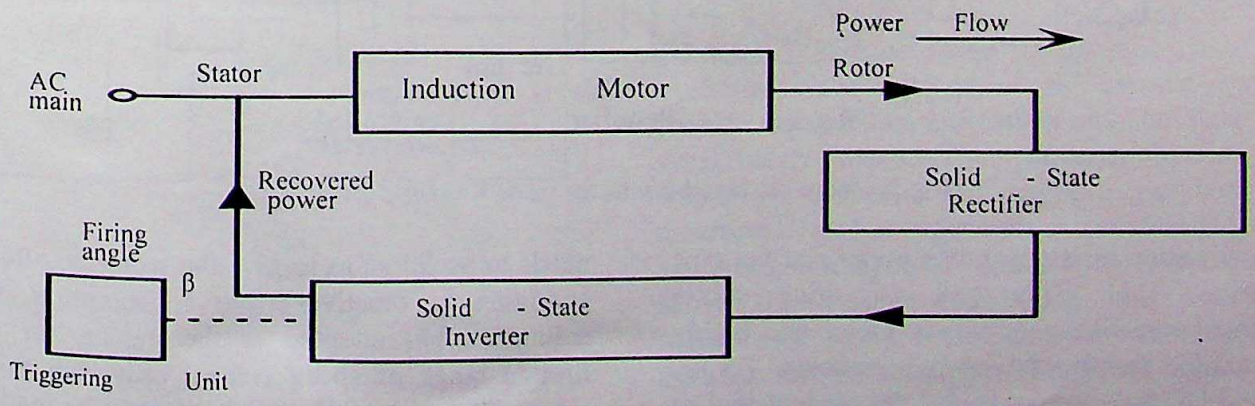


Fig.1: Slip power recovery scheme

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

This method recovers and delivers the slip power from WRIM to the source. At changeover speed, SPRS is connected to rotor and rotor resistance is disconnected. Diode rectifier converts the rotor voltage to DC voltage. This rectified voltage is counter balanced by a line commutated inverter. By controlling the counter balancing inverter voltage, the rotor current, hence rotor speed is regulated. The slip power collected at the slip rings is fed back to the supply through the inverter [7]. Basic block diagram of SPRS is shown in the figure 1.

Slip power recovery drives come across few challenges like maintaining of system stability during recovery process. The problem of poor power factor and highly variable reactive power consumption need to be addressed. Harmonic analysis of the system shows that these drives generate sub-harmonics of the supply frequency which could possibly cause flicker in weak electrical systems [8]. The effect of instantaneous power supply failure on the slip energy recovery drive is a challenge and has been discussed [9].

2. SLIP POWER RECOVERY SCHEMES

Previously, the scheme was implemented employing rotory converters and was categorized into the Kramer's drive and the Scherbius' drive. With the evolution in power electronics, the rotary converters of classical slip power recovery systems have now been replaced by power converters and two category of the scheme *viz.* static Kramer's drive and the static Scherbius' drive came into existence.

2.1 Static Kramer's Drive

Slip power controlled drive that permits only a sub-synchronous range of speed control through a converter cascade is known as a static Kramer's drive [10]. In static Kramer's drive, the rotor power from the wound rotor induction motor is fed back to the AC supply by a 3-phase diode bridge rectifier and a line commutated fully controlled inverter as shown in figure 2.

The machine air gap flux is established by the stator supply and it practically remains constant if the stator voltage drops and supply voltage fluctuations are neglected. Investigation of the scheme configuration during steady-state operation reveals that the rotor phase voltage and rotor current are in same phase. Further this operation implies that rectified slip voltage and inverter DC voltage are balanced. The drive system has the characteristics similar to a separately excited DC motor as the air gap flux is nearly constant and the torque is directly proportional to DC link current. This drive system finds its

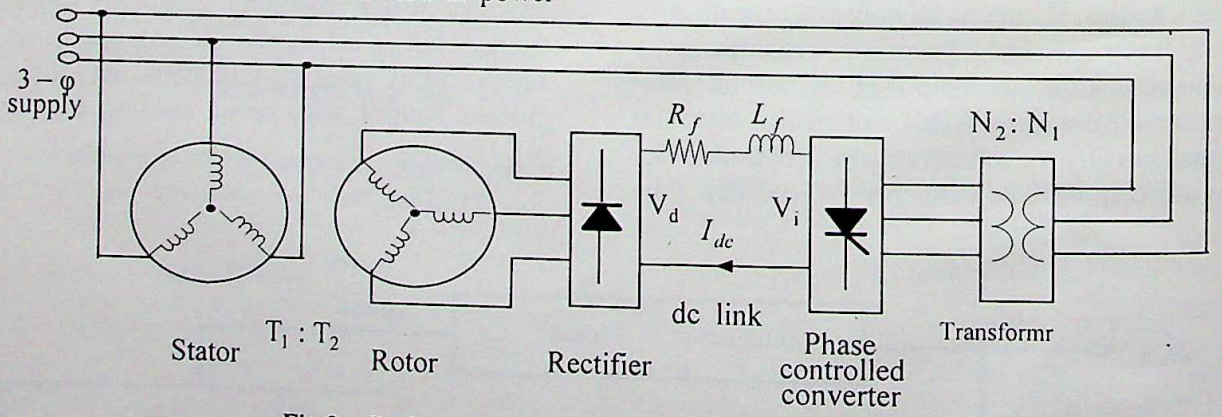


Fig.2: Basic circuit schematic for static Kramer's drive.

application in larger power pump and fan type drives [11]. This type of drive shows drawbacks like poor power factor and highly variable reactive power requirements. Torque and DC link current is directly proportional to speed and at higher speed inverter firing angle needs to be 90° so as to give the worst possible condition for reactive power consumption. A solution often adopted is the design for a limited range of speed control only, but this means that extra costly provision must be made for starting the motor and running it up to the

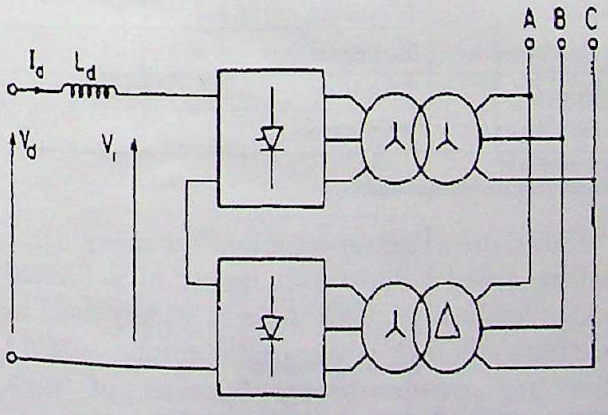
CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

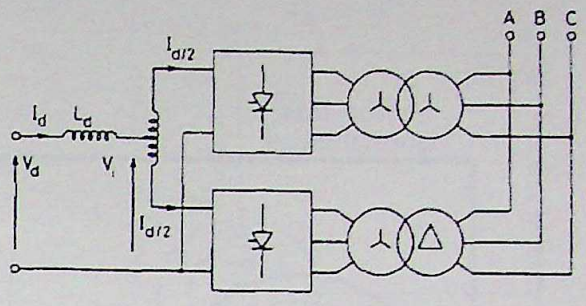
minimum controllable speed. For these reasons, there has been continuing interest in recovery inverter systems which might improve the performance of both full- and limited range drives. The four advanced recovery inverter system are described by B.A.T. Al Zawhai and B.L. Jones [12] as follows:

(i) 3N- Three-phase fully controlled bridge, depicted in figure 3 (a), and also used as the standard for comparison of different topologies of recovery system.
(ii) 12P -Twelve pulse inverter containing two three-phase bridge connected in series and in parallel as shown in figure 3 (b) for higher speed operation. This scheme is normally used in water pumping stations.
(iii) 3BB - A buck-boost series arrangement of two three-phase bridges shown in figure 3 (c) with asymmetric firing sequences. This technique commonly used to minimize reactive power variation.
(iv) 3SF- A series arrangement of three single-phase bridges, with fly-wheeling diode applied to each bridge separately which constitutes this system as in figure 3 (d). Use of fly-wheeling diodes reduces the RMS current and power losses in recovery transformer.

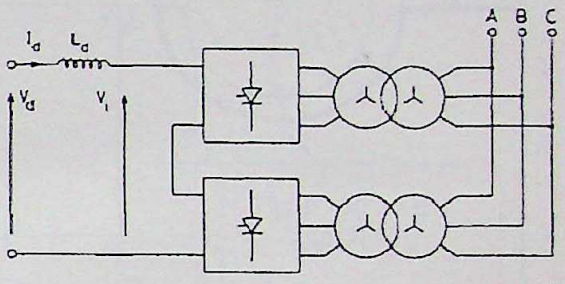
Kramer's drive has the limitation of one quadrant speed control and it cannot have regenerative braking capability, hence, speed reversal is not possible.



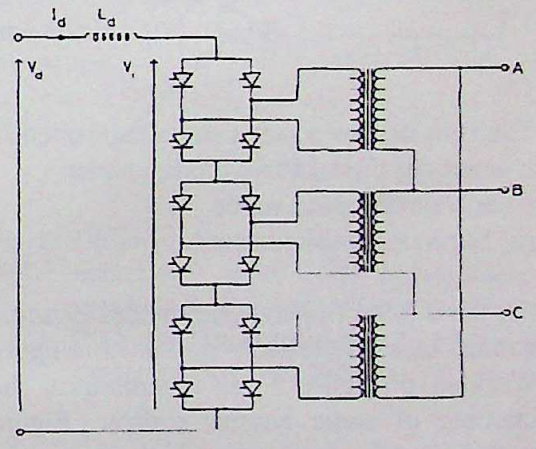
(a)



(b)



(c)



(d)

Fig.3: Different configurations for recovery inverter system (a) 3N (b) 12P (c) 3BB (d) 3SF

2.2 Static Scherbius' Drive

Static Scherbius' drive is capable to provide the speed control below and above the synchronous speed. The converter system, which is bidirectional, can provide both motoring as well as regeneration operation [13] as depicted in figure 4. For driving the rotor above the synchronous speed, the phase sequence of the rotor currents is reversed from that for the stator supply. Thus, slip speed becomes negative forcing the rotor speed to run above the synchronous speed.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

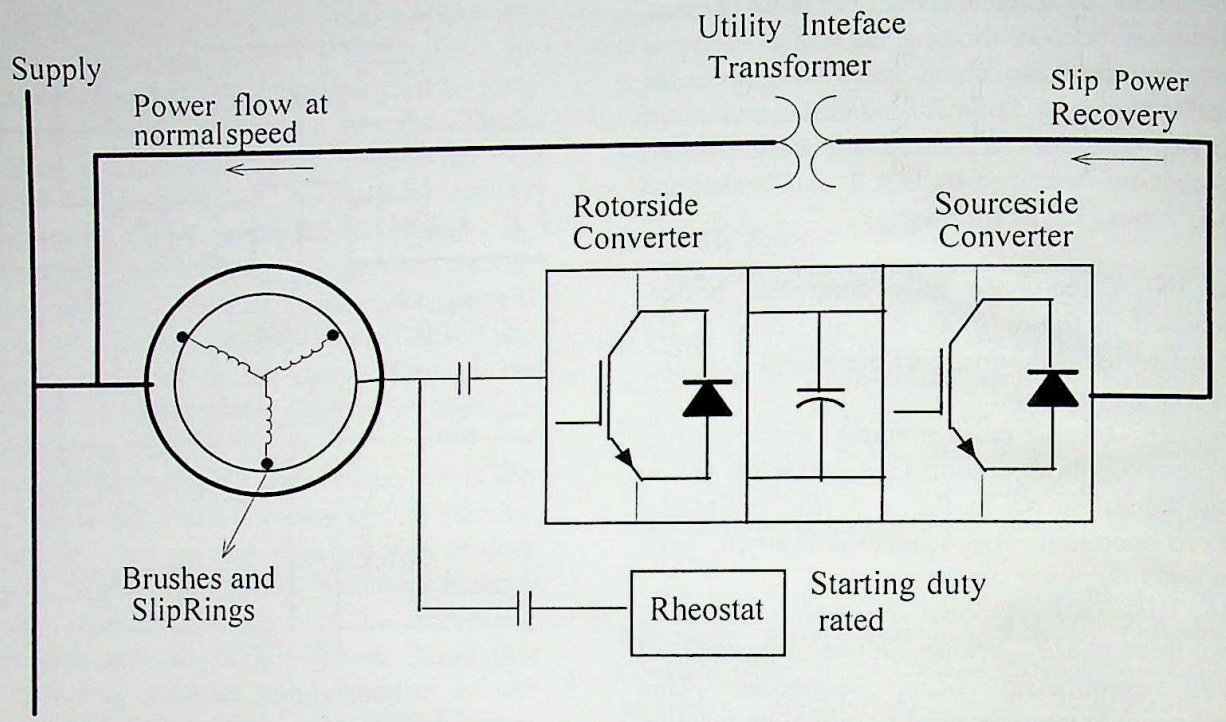


Fig.4: Basic circuit schematic for static Scherbius' drive.

The flow of slip power can be controlled in both directions through two modes, namely,

(i) Sub-synchronous mode

(ii) Super-synchronous mode.

All the different operational modes of static Scherbius' drive are broadly explained in figure 5. Working of figure 5 (a) is similar to the functioning of static Kramer's drive. Figure 5(b) explains the regenerative braking in sub-synchronous mode. In this mode, shaft is driven by the load and the mechanical energy is converted into electrical energy and extracted out of the stator. Normally synchronous speed is equal to the sum of slip speed and rotor speed, but due to phase reversal of stator supply, slip becomes negative and motor runs above synchronous speed which is termed as super-synchronous speed. In super-synchronous motoring mode, the shaft speed increases beyond the synchronous speed and the slip power is absorbed by the rotor as depicted in figure 5(c) & 5(d) depicts the super-synchronous regeneration. In this mode, the stator output power remains constant but the additional mechanical power input is reflected as slip power output [14]. The various modes of operation are summarized in Table 1.

Table 1: Different operational modes of static Scherbius' Drive [2].

Mode	Action	Slip	Slip Power
Sub-synchronous	Motoring	+	+
	Regeneration	+	–
Super-synchronous	Motoring	–	–
	Regeneration	–	+

This drive has applications in those areas where speed control required is in a limited range application. This drive is widely used in medium and high power (up to around 10MW) fan and pump drives, because of high efficiency and low cost [15,16].

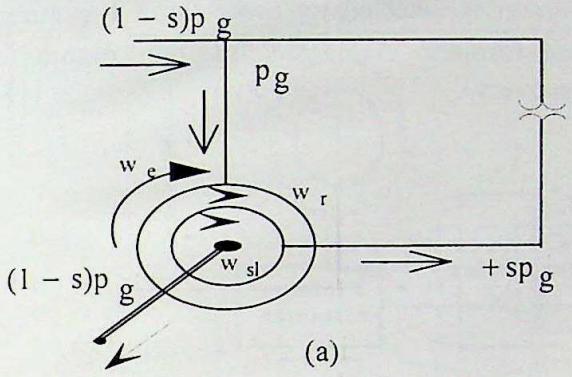
3. STABILITY OF SLIP POWER RECOVERY SYSTEM

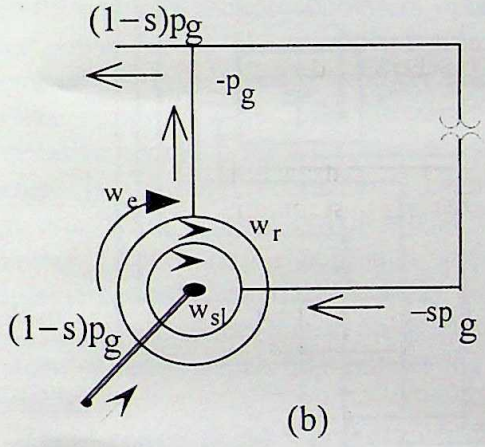
The most distinct feature for variable speed drive system is its stability. The stability of SPRS is governed by its control scheme.

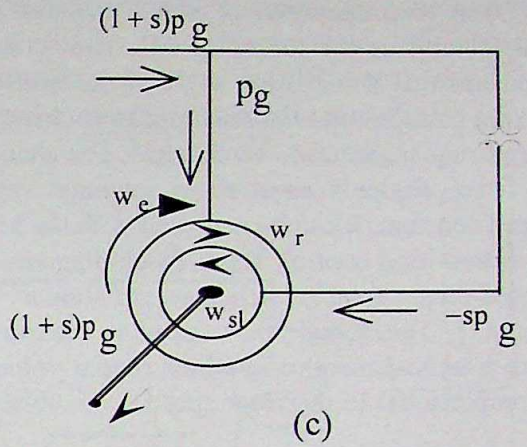
CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Control strategies are categorized such as shown in figure 6. The open loop control is further classified as open loop rotor voltage control and open loop rotor current control [17]. Open loop controllers were designed only for a limited range of speed variation.







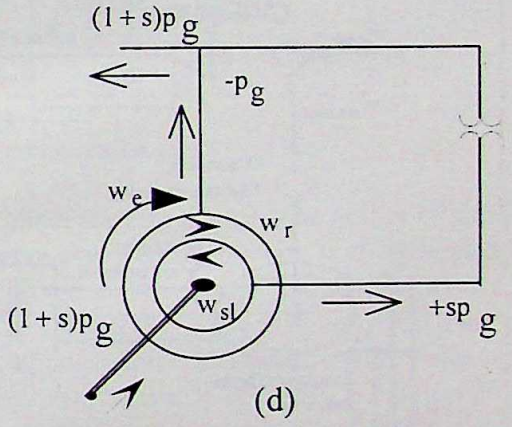


Fig. 5: Different operational modes of static Scherbius' drive (a) Sub-synchronous motoring (b) Sub-synchronous regeneration (c) Super-synchronous motoring (d). super-synchronous regeneration

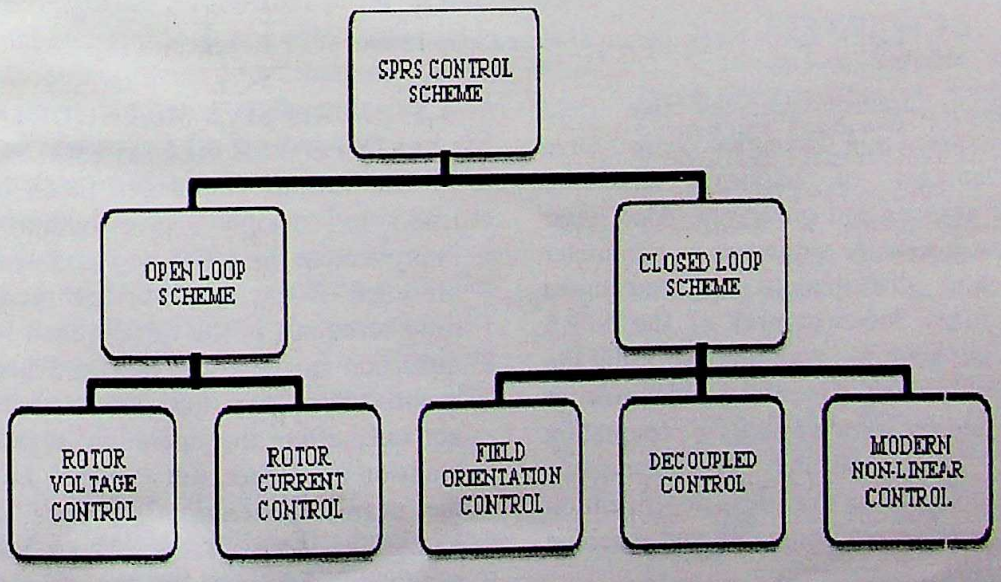


Fig. 6: Classification of SPRS control schemes [17].

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Open loop operation of SPRS may not be satisfactory, as the torque-speed characteristic indicates that if the firing angle of the inverter is kept constant and the load torque is changed then firing angle has to be changed. The change in firing angle is required to maintain rotor speed constant. It can be achieved with the help of closed-loop control. Basic block-diagram of closed-loop control scheme is shown in figure 7. The actual rotor speed is measured with a tacho-generator in which output voltage is proportional to the rotor speed. This voltage is compared with the reference value of the speed by means of a speed PI controller. Output obtained at this stage is served as the reference current input of the current PI controller. The output of the current PI controller provides the reference value of the firing angle. The actual value of DC link current is detected by using three 1-ϕ current transformers connected to the output of recovery inverter [18].

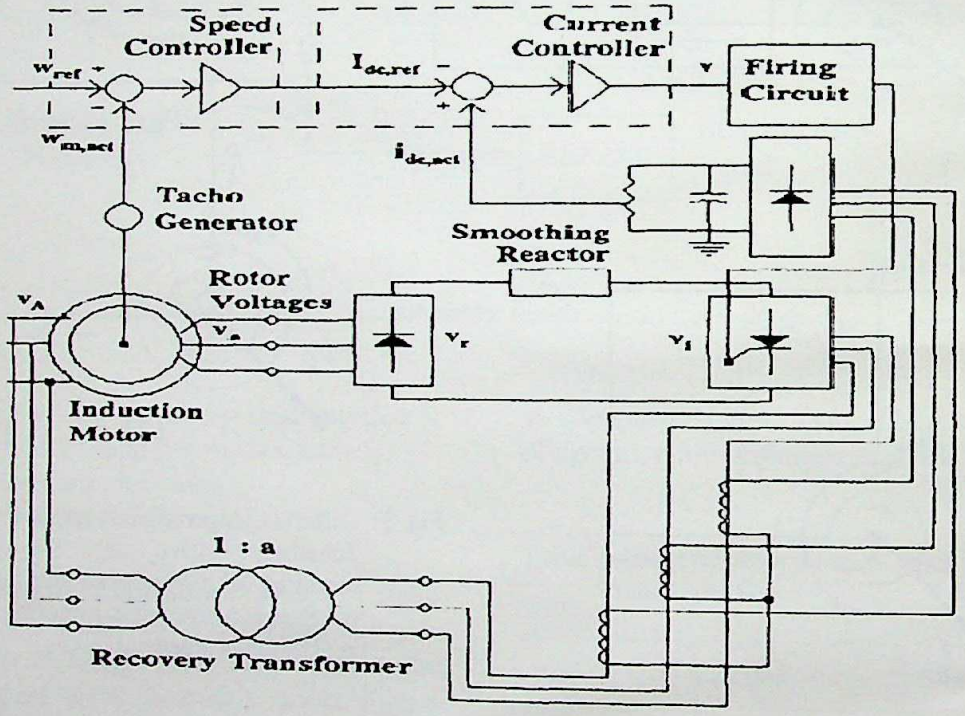


Fig. 7: Basic block digram of closed loop control of SPRS scheme [18].

Closed-loop control schemes like field orientation control and decoupled control have the disadvantages of requiring excessive numbers of sensors and observers. Also, their performance is usually subjected to parameter variations and disturbances. An advanced technique, fuzzy logic control of the SPRS would provide a simple way of controlling the complex doubly-excited machine and converter system. By adding some capacity of adaptation to the fuzzy logic controller, the performance of the system would be even less dependent on changing operating environments and machine parameters [19].

4. PROGRESSIVE METHODOLOGIES IN SLIP POWER RECOVERY SCHEME

The various challenges faced by a SPRS lead to further investigation for its improvement in efficiency and stability. The presence of the diode bridge rectifier at the rotor terminals of the SPRS result in harmonic distortion in the rotor flux and hence, in the stator current and flux. These harmonics may not only effect the operation of other sharing loads on the feeder, but also may be injected to the nearest generating stations. The current harmonics increases the copper losses in the stator windings while the flux harmonics increase the core loss in motor body [20].

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Marques *et al.* suggested advanced circuit configuration to compensate both flux and current harmonics [21]. As shown in figure 8, additional inductor is introduced to increase overlap angle and also connecting VSI to compensate stator current harmonics. Another approach for compensation of harmonics involves discrete wavelet transforms (DWT) and symmetrical component analysis [22].

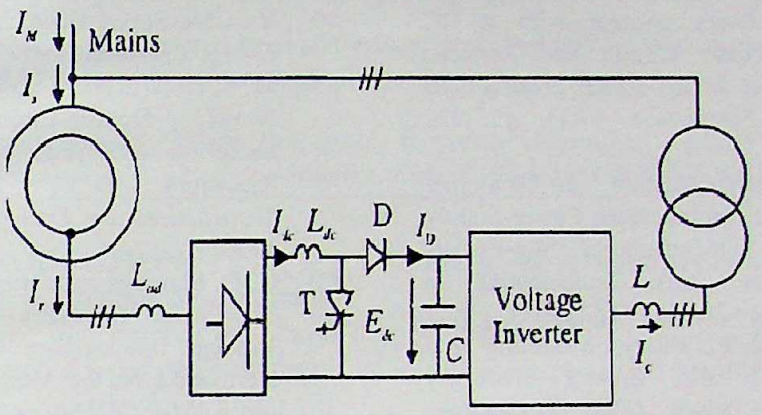


Fig. 8: Configuration for harmonic compensation given in [21].

SPRS using cascade converters operates at poor power factor. The reason for poor power factor of the drive is reactive power absorption by the motor, inverter and the rectifier. An alternative approach for improvement of power factor is through capacitor commutated converter (CCC) technology in the SPRS [23]. Another advanced approach is the implementation of an adaptive fuzzy technique [24]. This technique based on a three level control structure which manipulates the system variables.

The conventional proportional-integral-derivative regulators are utilized in the design of both inner current loop and outer speed loop control. Control systems adopt these regulators and when it is subjected to the external load changes or power grid fluctuation; these do not show satisfactory dynamic performance. The improvement in dynamic performance is obtained through closed-loop control system based on auto-disturbance-rejection-controller [25]. The auto–disturbance–rejection controller is chosen to control the speed for estimating and compensating the uncertainties in the motor system [26].

5. CONCLUSIONS

Slip power recovery drive is advantageous over other high power medium voltage drives as it is having energy saving, lower cost and simple starting device. The ability of slip power recovery drive to operate with any rated stator voltage makes it more industrial friendly. With the provision of additional reactive power compensation available with slip power recovery drive, it becomes a viable option for variable speed drive application. Recently various control strategies are devised for optimal performance of the slip power recovery drives. With the new developments in slip power recovery scheme it is now possible to permanently eliminate the harmonics resulting in good power quality.

REFERENCES

[1] D. S Henderson, Variable Speed Electric Drives Characteristics and Applications, *IEEE*, Savoy Place, London WCPR OBL, UK, *1996.*

[2] R. Krishnan, Electric Motor Drives- Modeling, Analysis and Control, 2003.

[3] J.E. Brown, W. Drury, B. L. Jones and P. Vas., Analysis of the Periodic Transient State of a Static Kramer Drive, *Proc IEE*, 112 Pt 9. (1), 21-30 (1986).

[4] E. Akpinar and P. Pillay, Modeling and Performance of Slip Energy Recovery Induction Motor Drives, *IEEE Trans. On Energy Conversion* 5 (1), 203-210 (1990).

[5] Lili Bu, Chun Li, Jeff Krukowski, Wilsun Xu, and Xian Liu, A New Energy Recovery Double Winding Cage Rotor Induction Machine, *IEEE Transactions on Energy Conversion* 18 (2), 315-320 (2003).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

[6] M.S. Erlicki, Inverter rotor drive of an induction motor, *IEEE Trans. On Power System and Apparatus* 84, 1011-1016 (1965).

[7] B. M. Bird, and P. Mehta, Regenerative Braking in Slip-Power-Recovery Systems, *Proc. IEE* 119 (9), 1972.

[8] G. D. Marques and Pedro Verdelho, A Simple Slip-Power Recovery System with a DC Voltage Intermediate Circuit and Reduced Harmonics on the Mains. *IEEE Transactions on Industrial Electronics* 47(1), 123-232 (2000).

[9] Isik Çadirci, Gokhan Akçam, and Muammer Ermi, "Effects of Instantaneous Power-Supply Failure on the Operation of Slip-Energy Recovery Drives, *IEEE Transactions on Energy Conversion* 20 (1), 7-15 (2005).

[10] E. Akplnar and P. Pillay, Modeling and Performance of slip Energy Recovery Induction Motor Drives, *IEEE Transactions on Energy Conversion* 5 (1), 203-210 (1990).

[11] R.M. Oloisscn, K. Aberg, P. Wikstrdm, A Reactorless Slip Recovery System, *ABB Drives AB, Sweden*, 306-311, 1998.

[12] B.A.T. AI Zahawi, B.L. Jones, W. Drury, Electrical characteristics of alternative recovery Convertors for slip-energy recovery drives, *IEE Proceedings-B* 138(4), 193-203 (1991).

[13] B.K.Bose, Power electronics and drive, 2005.

[14] G. A. Smith, Static Scherbius system of induction motor speed control, *Proc. IEE* 124, 557-565 (1977).

[15] S. Mori et al., Commissioning of 400 MW adjustable speed pump storage system of Ohkawachi power plant, *Proc. Cigre Symp.*, 559-574, 1995.

[16] B. Lequesne, A. R. Miles, Generalized Root-Loci Theory for The Static Scherbius Drive, *IEEE Transactions on Power Apparatus and Systems* 103 (6),1304-1313, (1984).

[17] Yilan Tang and Loongya Xu, Slip Power Recovery System Stability, *IEEE industry Applications Magazine*, May/June 1995

[18] E. Akpinar, R. E. Trahan, Modelling and Analysis of Closed-Loop Slip Energy Recovery Induction Motor drive Using A Linearization Technique, *IEEE Transactions on Energy Conversion* 8 (4), 1993.

[19] Yifan Tang Longya Xu, Fuzzy Logic Application for Intelligent Control of a Variable Speed Drive, *IEEE Transactions on Energy Conversion* 9 (4), 1994.

[20] W. S. Zakaria A. A. Shiiltout S. E. Alrvash , A Novel Double-Circuit-Rotor Balanced Induction MotorFor Improved Slip-Energy R,ecovery Drive Performance, *IEEE Transactions on Energy Conversion*, 11 (3), 1996.

[21] G. D. Marques and Pedro Verdelho, A Simple Slip-Power Recovery System with a DC Voltage Intermediate Circuit and Reduced Harmonics on the Mains, *IEEE Transactions on Industrial Electronics*, 47 (1), 2000.

[22] H.T.Yalazan, T. Sürgevil, and E. Akpinar, Wavelet Transform Application in Active Power Filter Used for Slip Energy Recovery Drives, *IEEE*, 2007.

[23] Aimeng Wang, Yamin Yuan, The Capacitor Commutated Converter (CCC) as an Alternative for Application in Slip-Energy Recovery Drives.

[24] L.E. Eorgee da Silva, G.L. Ambert-Torresz, V.Ferreira da Silvaz and K. Nakashimal, Adaptive Fuzzy Techniques for Slip-Recovery Drive Control, *IEEE*, 1992.

[25] Ping Jiang, Bing shu Wang, Research on Auto Disturbance Rejection Control for Slip Power Recovery Induction Motor, *Proceedings of the Eighth International Conference on Machine Learning and Cybernetics, Baoding*, 2009.

[26] Ping Jiang, Bingshu Wang and Junwei Zhang, Simulation of A New Method in Double closed loop for Slip Power Recovery Motor with Chopper, *Proceedings of the IEEE International Conference on Mechatronics and Automation*, Changchun, China, *2009*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Journal of Natural & Physical Sciences
ISSN 097-3799
Digitized by Arya Samaj Foundation Chennai and eGangotri
JNPS
J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.29-34 (2011)

A Fixed Point Theorem of Systems of Maps on Product Spaces

Ritu Arora
Department of Mathematics & Statistics, Gurukula Kangri Vishwavidyalaya, Haridwar, India
(**Email:** ritu.arora29 @gmail.com)

ABSTRACT- The purpose of this paper is to obtain a fixed point theorem for four systems of Matkowski type maps on a finite product of complete metric spaces.

KEYWORDS: Fixed point, weakly commuting maps, R-weakly commuting maps, Coordinatewise weakly commuting maps, Coordinatewise R-weakly commuting maps, Coordinatewise coincidently maps.

1. INTRODUCTION

In 1976, Jungck [1] obtained a common fixed point theorem for commuting maps generalizing the Banach's fixed point theorem. This result was first generalized by Singh [2]. Jungck's result and Singh's generalizations gave a new direction of work in contractive fixed point theory. Consequently, numerous extensions, generalizations and applications were proposed [1-13].

In 1973, Matkowski [14,15] obtained a new contraction principle, in fact an extension of the well known Banach contraction principle, for a system of maps on a finite product of metric spaces (*Theorem 1*). Theorem 1 (generally called the Matkowski Contraction Principle or briefly MCP) has been studied on various settings, and its extensions and generalization encompass several general results from contractive fixed point theory [3,11,15-19].

Kominek [20] and Singh *et al.* [21] independently unified apparently diverse developments of Jungck type contractive maps and Matkowski type maps in a natural way. Singh et al. [2] introduced weakly commuting and asymptotically commuting (also called compatible maps) for Jungck–Matkowski type maps on product spaces. This paved the way to study hybrid type maps on these settings as well [16,17].

In this paper, we obtained a fixed point theorem for four systems of Matkowski type maps on a finite product of complete metric spaces.

2. PRELIMINARIES

We shall follow the following notations and definitions from Matkowski [14,18]

Let a_{ik} be nonnegative numbers, i, k = 1,..., n, and $c_{ik}^{(t)}$ square matrices defined in the following recursive manner

$$c_{ik}^{(0)} = \begin{cases} a_{ik}, & for\ i \neq k \\ 1 - a_{ik}, & for\ i = k \end{cases} \quad (1)$$

i, k = 1, ..., n, and c_{ik} are defined recursively by

$$c_{ik}^{(t+1)} = \begin{cases} c_{11}^{(t)}\ c_{t+1,k+1}^{(t)} + c_{t+1,1}^{(t)}\ c_{1,k+1}^{(t)} & for\ i \neq k \\ c_{11}^{(t)}\ c_{t+1,k+1}^{(t)} - c_{t+1,1}^{(t)}\ c_{1,k+1}^{(t)} & for\ i = k \end{cases} \quad (2)$$

i, k = 1,2..., n – t –1, t = 0,1,2 ..., n – 2.

If n = 1, we define $c_{11}^{(0)} = a_{11}$.

The following lemma is essentially due to Matkowski et al. [11,15,18].

Lemma: Let $c_{ik}^{(0)} > 0$, i, k = 1, 2,.., n, n ≥ 2 then the system of inequalities

$$\sum_{k=1}^{n} a_{ik} r_k < r_i, \quad i, k = 1, \ldots, n, \quad (3)$$

has a solution $r_i > 0$, $i = 1,2,...,n$, if and only if

$$c_{ii}^{(t)} > 0, \quad i = 1, 2, \ldots, n - t, \quad t = 0, 1, \ldots, n-1 \quad (4)$$

hold. Indeed, there exists a number h ∈ (0, 1) such that

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$$\sum_{k=1}^{n} a_{ik} r_k \leq h r_i, \quad i,k = 1,2,\ldots,n \tag{5}$$

for some positive numbers $r_1, r_2, \ldots, r_n$, [15, 20].

$$h = \max_i \left\{ r_i^{-1} \sum_{k=1}^{n} a_{ik} r_k \right\} \tag{6}$$

Let (X_i, d_i), $i = 1,2,\ldots,n$, be metric spaces,

$X := X_1 \times X_2 \times \ldots \times X_n$,

and

$x^m := (x_1^m, \ldots, x_n^m)$,

$x_i^m \in X_i$, $i = 1,2,\ldots,n$; $m = 0,1,2,\ldots$

Also,

$x := (x_1, \ldots, x_n)$, $x_i \in X_i$, $i = 1,2,\ldots,n$.

Thus

$y \in X$ *means* $y := (y_1, \ldots, y_n)$.

Theorem 1 [14,15]

Let (X_i, d_i), $i = 1,2,\ldots,n$ be complete metric spaces and

$T_i : X \to X_i$, $i = 1,2,\ldots,n$, such that

$$d_i(T_i x, T_i y) \leq \sum_{k=1}^{n} a_{ik} d_k(x_k, y_k), \quad i = 1,2,\ldots,n, \tag{7}$$

for every $x_k, y_k \in X_k$, $i,k = 1,2,\ldots,n$ where a_{ik} are nonnegative numbers such that the matrices defined in Eq. (1) and Eq. (2) satisfy the condition as in Eq. (3). Then the system of equations

$$T_i x = x_i, \quad i = 1,2,\ldots,n, \tag{8}$$

has exactly one solution $p := (p_1, \ldots, p_n)$ such that $p_i = X_i$, $i = 1,\ldots,n$.

Further, for any $x^0 \in X$, the sequence of successive approximations

$$x_i^{(m+1)} = T_i x^m, \quad i = 1,2,\ldots,n, \quad m = 0,1,2,\ldots \tag{9}$$

converges and

$$p_i = \lim_{m \to \infty} x_i^m, \quad i = 1,\ldots,n \tag{10}$$

The system of maps $(T_1, \ldots, T_n)$ (which henceforth, will be denoted by (T_i)) on X with values in metric spaces X_i, $i = 1,\ldots,n$, satisfying Eq. (7) may be called the system of contractions on a product of metric spaces (or simply Matkowski Contraction on product of spaces), wherein Eq. (1) to Eq. (3) hold.

Notice that Theorem 1 with n = 1 is the well known Banach Contraction Principle (BCP). We remark that Theorem 1 becomes equivalent to BCP if the Matrix (a_{ik}) is symmetric [18].

Theorem 2 [3]

Let (X_i, d_i), $i = 1,\ldots,n$, be metric spaces and

$P_i, Q_i, S_i, T_i : X \to X_i$, $i = 1,\ldots,n$, such that

$$P_i(X) \cup Q_i(X) \subset S_i(X) \cap T_i(X), \quad i = 1,\ldots,n; \tag{11}$$

One of $P_i(X)$ *or* $Q_i(X)$ *or* $S_i(X) \cap T_i(X)$ is a complete subspace of X_i, $i = 1,\ldots,n$; (12)

$$d_i(P_i x, Q_i y) \leq \max\left\{ \sum_{k=1}^{n} a_{ik}\, d_k(S_k x, T_k y),\ b \max[d_i(S_i x, P_i x), d_i(T_i y, Q_i y), \tfrac{1}{2}\{d_i(S_i x, Q_i y) + d_i(T_i y, P_i x)\}] \right\} \tag{13}$$

$\forall$ *x, y in X, where* a_{ik} *and* b are non negative numbers, b < 1 and Eq. (1), Eq. (2) and Eq.(3) hold.

If (P_i) & (S_i) *and* (Q_i) & (T_i) are pair wise coordinate wise coincidently commuting, then the system of equations

$$P_i x = S_i x = x_i = Q_i x = T_i x, \quad i = 1,\ldots,n, \tag{14}$$

has a unique solution in X.

3. DEFINITIONS

In all that follows let (X_i, d_i), $i = 1,\ldots,n$, be metric spaces and P_i, Q_i, S_i, T_i Maps from

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$X := X_1 \times X_2 \times \ldots \times X_n$, to X_i, $i = 1,\ldots,n$. The system of maps $(P_1, \ldots, P_n)$, as before, will be denoted by (P_i).

Definition 1 [7, 8]: Two systems of maps (P_i) and (S_i) are coordinate wise commuting at a point $x \in X$ if and only if

$$P_i(S_1x,\ldots,S_nx) = S_i(P_1x,\ldots P_nx),\ i=1,\ldots,n$$

The two Systems (P_i) and (S_i) are coordinate wise commuting on X if and only if they are coordinate wise commuting at every point of X.

Definition 2: Two systems of maps (P_i) and (S_i) are coordinate wise R-weakly commuting if there exists an $R > 0$ such that for each $x \in X$,

$$d_i(P_i(S_1x,\ldots,S_nx), S_i(P_1x,\ldots,P_nx)) \le Rd_i(P_ix,S_ix),\ i=1,\ldots,n$$

Definition 2 with R = 1 is the definition of coordinate wise weakly commuting systems of maps (P_i) and (S_i) due to Gairola *et al.* [7-8,16]. Evidently definition 2 with r = 1 and n = 1 says that P_1 and S_1 are weakly commuting [21].

Definition 3: Let Y be a metric space and $P, S : Y \to Y$.

Then, maps P and S are weakly compatible if they commute at their coincidences points, that is, if $PS_y = SP_y$, whenever $P_y = S_y$ *for* $y \in Y$.

However, Singh [21] in 1986 and Singh and Pant [22] in 1988 used this concept without giving any name while establishing common fixed point theorems for maps on non-complete spaces. Subsequently, this concept has been widely used [7,12] and elsewhere. We extend this concept to two systems of maps selecting appropriate and popular terminologies.

Definition 4: Two systems of maps (P_i) and (S_i) will be called coordinate wise coincidently commuting or coordinate wise weakly compatible if

$$P_i(S_1x,\ldots,S_nx) = S_i(P_1x,\ldots,P_nx)$$

Whenever

$$P_ix = S_ix,\ i=1,\ldots,n,\ x \in X$$

It is well known that weakly commuting pair of maps is compatible, and a compatible pair of maps is weakly compatible. However, the reverse implication need not be true. This remark applies to two systems of maps. For an excellent comparison of weaker forms of commuting maps on a metric space, refer to Singh and Tomar [23], Murthy [10] and Pathak and Khan [24].

Theorem: Let (X_i, d_i), $i = 1,\ldots,n$, be complete metric spaces and

$P_i, Q_i, S_i, T_i : X \to X_i$, $i = 1,\ldots,n$, such that Eq.(13) and following hold:

$$P_i(X) \subset T_i(X),\ Q_i(X) \subset S_i(X),\ i=1,\ldots,n; \tag{15}$$

One of P_i *or* Q_i *or* S_i *or* T_i, is continuous $i = 1,\ldots,n$, (16)

systems of maps $(P_1,\ldots,P_n)$ & $(S_1,\ldots,S_n)$ and $(Q_1,\ldots,Q_n)$ & $(T_1,\ldots,T_n)$ are coordinate wise R-weakly commuting. (17)

Then the system of Eq. (14) has a unique common solution $x_1,\ldots,x_n$ such that $x_i \in X_i$.

Proof: Pick $x_i^{(0)} \in X_i$, $i = 1,\ldots,n$. In view of Eq.(15), if we construct a sequences $\{x_i^m\}$ *and* $\{z_i^m\}$ *in* X_i such that

$$P_i x^{2m} = T_i x^{2m+1} = z_i^{2m+1}$$

and

$$Q_i x^{2m+1} = S_i x^{2m+2} = z_i^{2m+2}\ m = 0, 1, 2, \ldots.$$

In view of *Theorem 2* $\{z_i^m\}$ is a Cauchy sequence. Since X_i is complete, it has a limit in X_i, call it u_i, $i = 1,\ldots,n$. Notice that subsequences $\{z_i^{(2m+1)}\}$ and $\{z_i^{(2m+2)}\}$ have also the same limit. If S_i be continuous, then $S_i\{z_i^{2m}\}$ is convergent to S_iu. So by Eq. (17);

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$d_i(P_i(Z_1^{2m+2},\ldots,Z_n^{2m+2}), S_iu) \le Rd_i(P_i(Z_1^{2m+2},\ldots, Z_n^{2m+2}), S_i(Z_1^{2m+3},\ldots,Z_n^{2m+3})$

$+ d_i(S_i(Z_1^{2m+3},\ldots,Z_n^{2m+3}), S_iu)$,

$\le Rd_i(Z_i^{2m+3}, Z_i^{2m+2}) + d_i(S_i(Z_1^{2m+3},\ldots,Z_n^{2m+3}), S_iu.$

Taking $m \to \infty$ it is clear that

$P_i(Z_1^{2m+2},\ldots,Z_n^{2m+2}) \to S_iu$

From (14)

$P_i(Z_1^{2m+2},\ldots,Z_n^{2m+2}),\ Q_i(x^{2m+1})$

$\le \max\left\{\sum_{k=1}^{n} a_{ik}\, d_k(S_k(Z_1^{2m+2},\ldots,Z_n^{2m+2}),\ Z_k^{2m+1}),\right.$

$b\max\{d_i(S_i(Z_1^{2m+2},\ldots,Z_n^{2m+2}), P_i(Z_1^{2m+2},\ldots,Z_n^{2m+2}), d_i(Z_i^{2m+1}, Z_i^{2m+2})\},$

$\left.\tfrac{1}{2}[d_i(S_i(Z_1^{2m+2},\ldots,Z_n^{2m+2}), Z_i^{2m+2}) + d_i(Z_i^{2m+1}, P_i(Z_1^{2m+2},\ldots,Z_n^{2m+2}))]\right\}.$

It can be assumed without any dispute that

$m \to \infty$

$d_i(S_iu, u_i) \le r_i$.

$d_i(s_iu, u_i) \le \max\left\{\sum_{k=1}^{n} a_{ik}\, d_k(s_ku, u_k),\right.$

$\left.\{b(s_iu, s_iu), d_i(u_i, u_i), \tfrac{1}{2}[d_i(s_iu, u_i) + d_i(u_i, s_iu)]\}\right\}$.

$\le \max\{hr_i, br_i\}$

$\le cr_i$ *where* $c = \max\{h, b\}$

Inductively, $d_i(S_iu, u_i) \le c^m r_i, \quad i = 1,\ldots,n.$

It clearly states that $S_iu = u_i, \quad i = 1,\ldots,n.$

From Eq. (14)

$d_i(P_iu, Q_ix^{2m+1}) \le \max\left\{\sum_{k=1}^{n} a_{ik}\, d_k(S_ku, Z_k^{2m+1}),\right.$

$b\max\{(S_iu, P_iu), d_i(Z_i^{m+1}, Z_i^{m+2}),$

$\left.\tfrac{1}{2}[d_i(S_iu, Z_i^{m+2}) + d_i(Z_i^{m+1}, P_iu)]\}\right\}$.

$d_i(p_iu, u_i) \le bd_i(u_i, p_iu)$

$p_iu = u_i, i = 1,\ldots,n$ (18)

Since range of P_i is contained in range of T_i; therefore vi be a point in $T_i^{-1}X_i$

such that

$T_iv_i = u_i, \quad i = 1,\ldots,n.$

Therefore,

$Q_i(T_1v_1,\ldots,T_nv_n) = Q_iu.$

Such that

$d_i(u_i, Q_iv_i) = d_i(P_iu, Q_iv_i)$

$\le \max\left\{\sum_{k=1}^{n} a_{ik}\, d_k(S_ku, T_kv_k),\right.$

$b\max\{d_i(S_iu, P_iu), d_i(T_iv_i, Q_iv_i),$

$\left.\tfrac{1}{2}[d_i(S_iu, Q_iv_i) + d_i(T_iv_i, P_iu)]\}\right\}$.

$= bd_i(u_i, Q_iv_i)$

Therefore,

$Q_iv_i = u_i, \quad i = 1,\ldots,n.$ Now systems of maps $(T_1,\ldots,T_n)$ and $(Q_1,\ldots,Q_n)$ on coordinate wise R-weakly commuting maps.

$d_i(Q_i(T_1v_1,\ldots,T_nv_n)),\ T_i(Q_1v_1,\ldots,Q_nv_n)$

$\le Rd_i(T_iv_i, Q_iv_i) = d_i(u_i, u_i) = 0$

Clearly,

$Q_iu = T_iu, \quad i = 1,\ldots,n.$

(19)

Clearly, we can assume that,

$d_i(u_i, Q_iu) \le r_i$.

$d_i(u_i, Q_iu) = d_i(P_iu, Q_iu)$

$\le \max\left\{\sum_{k=1}^{n} a_{ik}\, d_k(S_ku, T_ku),\right.$

$b\max\{d_i(S_iu, P_iu), d_i(T_iu, Q_iu),$

$\left.\tfrac{1}{2}[d_i(S_iu, Q_iu) + d_i(T_iu, P_iu)]\}\right\}$.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$\leq \max\{hr_i, br_i\}, \quad i = 1,2,...,n.$

$\leq cr_i \text{ where } c = \max\{h, b\}$

Inductively,

$d_i(u_i, Q_i u) \leq c^m r_i,$

As a result,

$Q_i u = u_i, \ i = 1,2,...,n.$

Such that

$$P_i u = Q_i u = u_i = S_i u = T_i u, \quad i = 1,...,n.$$

Clearly it state that if we assume that $S_i = i = 1,...,n$ to be continuous then the systems of equation will be unique common fixed point. If we assume S_i in place of T_i, $i = 1,...,n$ then it also can be proved in the similar manner.

The uniqueness of u_i, $i = 1,...,n$ follows easily.

Remarks:

i. Theorem 1 is obtained as a corollary of the above theorem when $P_i = Q_i$ *and* $x_i = S_i x = T_i x$ for each x_i *in* X_i

ii. A fixed point theorem for systems of maps due to Singh-Kulshrestha [25] is obtained from the above theorem when $X = X_i$. and $x_i = S_i \ x = T_i x, \ i = 1,...,n$

REFERENCES

[1] G. Jungck, Commuting maps and fixed points, *Amer. Math. Monthly* 83, 261-263 (1976).

[2] S. L. Singh, A new approach in numerical praxis, *Prog. Math.* 32(2), 75-89 (1998).

[3] Ritu Arora, Existence of coincidence and fixed points of maps and relations, Ph.D. thesis, Gurukul Kangari University, Hardwar, 2004.

[4] V. Conserva, Common fixed point theorems for commuting maps on a metric space, *Publ. Inst. Math.* 32 (46), 37-43 (1982).

[5] K. M. Das and K. V.Naik, Common fixed point theorems for commuting maps on a metric space, *Proc. Amer. Math. Soc.* 77, 369-373 (1979).

[6] B. Fisher and S. Sessa, Two common fixed point theorems for weakly commuting mappings, *Periodical Math. Hung.* 20, 207-218 (1989).

[7] U. C. Gairola, Existence of coincidence, fixed and hybrid fixed points in metric and Banache spaces, Ph.D. Thesis, Gurukula Kangri Vishwavidyalaya Hardwar, 1990.

[8] U. C. Gairola, S. L Singh., J. H. M Whitefield, Fixed point theorems on product of compact metric spaces, *Demonst. Math.* 28 541-548 (1995).

[9] H. K. Pathak, Y. J. Cho and S. M. Kang, Remarks on R-weakly commuting mappings and common fixed point theorems, Bull. *Korean math. Soc.* 34, 247-257 (1997).

[10] Murthy P. P., Important tools and possible applications of metric fixed point theory, *Nonlinear Analysis*, 47, 3479-3490 (2001).

[11] K. B. Reddy and P. V. Subrahmanyam, Extensions of Krasnoselskii's and Matkowski's fixed point theorems, *Funcial. Ekv.* 24, 67-83 (1981).

[12] S. Sessa, On a weak commutativity condition of mappings in fixed point considerations, *Publ. Inst. Math.(Beograd)* (N.S) 32 (46), 149-153 (1982).

[13] S. Sessa and B. Fisher, On fixed points of weakly commuting mappings in compact metric spaces, *Jñānābhā* 15, 79-91 (1985).

[14] J. Matkowaski, Some inequalities and a generalization of Banach's principle, Bull. Acad. *Polon. Sci. Sér. Sci. Math. Astronom. Phys.* 21, 323-324 (1973).

[15] J. Matkowaski, Integrable solutions of functional equations, *Dissertations Math.* 127 (Rozprawy), Warszawa, 1975.

[16] U. C. Gairola, S. N. Mishra and S. L. Singh, Coincidence and fixed point theorems on product spaces, *Demonst. Math.* 30(1), 15-24(1997).

[17] G. Jungck, Common fixed points for commuting and compatible maps on compacta, *Proc. Amer. Math. Soc.* 103 (3), 977-983 (1988).

[18] J. Matkowaski, and S. L. Singh, Banach type fixed point theorems on Product of spaces, *Indian J. Math.* 39 (3), 275-286 (1997).

[19] S. L. Singh and U. C. Gairola, A coincidence theorem for three systems of transformations, *Demonstration Math.* 23, 1990.

[20] Z. Kominek, A generalization of K. Goebel's and J. Matkowaski's theorems, *Univ. Śląski w Katowie, Prace Nauk.- Prace Mat.* 12, 30-33 (1982).

[21] S. L. Singh, Coincidence theorems, fixed point theorems and convergence of sequences of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

coincidence values, *Punjab Univ. J. Math.* 19, 83-97 (1986).

[22] S. L. Singh and B. D. Pant, Coincidence and fixed point theorems for a family of mappings on Menger spaces and extension to uniform spaces, *Math. Japan.* 33, 957-973 (1988).

[23] S. L. Singh and Anita Tomar, Weaker forms of commuting maps and existence of fixed points, *J. Korea Soc. Math. Educ. Ser. B: Pure Appl. Math.* 10 (3), 145-161(2003).

[24] H. K. Pathak and M. S. Khan, A comparison of various types of compatible maps and common fixed points, *Indian J. Pure Appl. Math.* 28 (4,) MR97m: 54069, 477-485 (1997).

[25] S. L. Singh and C. Kulshrestha, A common fixed point theorem for two systems of transformations, *Pusan. Kyõ. Math.* J. 2, 1-8 (1986).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Journal of Natural & Physical Sciences
ISSN 097-3799
Digitized by Arya Samaj Foundation Chennai and eGangotri
JNPS
J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.35-40 (2011)

Millimeter and Microwave Photonics Devices and Their Applications

Tarun Sharma[#] and Himanshu Monga
Department of Electronics & Communication Engg, Shoolini University, Solan (H.P), India
[#]Corresponding author (**Email**: sharma.tarun23@gmail.com)

ABSTRACT- Microwave photonics can be generally defined as the study of high-speed photonic devices operating at microwave or millimeter wave frequencies and their use in microwave or photonic systems. In this multidisciplinary field at the interface between microwave techniques, ultra fast electronics and photonic technologies, typical investigations include, for example, high-speed and microwave signal generation, processing and conversion as well as the distribution and transmission of microwave signals via broadband optical links. From pioneering experiments in the 70´s, this field of microwave photonics has paved the way for an enabling novel technology with a number of commercially important applications. This paper is intended to give an overview on this multidisciplinary field of microwave and millimeter wave photonics.

1. INTRODUCTION

Within the last decade the field of microwave photonics has attracted growing interest worldwide. The term of microwave photonics was introduced in 1991 and used to describe novel optoelectronic components based upon the interaction of traveling optical and microwaves [1,2]. In the following, the merging of microwave and photonic technologies was foreseen to be a new approach for future fiber radio communication systems where the RF signal is transmitted over optical carriers [3]. Since then the field of RF optoelectronics and photonics rapidly broadened: Since 1996 International Topical Meetings on Microwave Photonics (MWP) are being held annually [4] and 1995 was the first year of an IEEE MTT Special Issue on Microwave Photonics now being published regularly [5]. Microwave photonics [6] is an innovative multi-and interdisciplinary field combining and transferring different technologies. In particular, microwave technologies are used and employed in photonics and photonic technologies are utilized in microwave techniques. Moreover, in specific areas novel synergistic concepts have been developed by merging both technologies which particularly holds for the field of optoelectronics as their interface. As a result of ever increasing frequencies the term microwave stands here for GHz or THz frequencies in the frequency and equivalently for ps- or fs-time scales in the time domain. This paper is intended to give an overview on this field of microwave photonics together with recent results ranging from devices and technologies to specific under investigation. In particular, the following topics will be addressed by way of key examples for the synergetic mixture of the two technologies involved: (i) Ultra fast photonic components such as optical modulators and detectors with special emphasis on traveling wave devices (ii) Broadband analog optical links for high-speed interconnects and (iii) Microwave photonic systems based upon the merging of microwave and optical technologies.

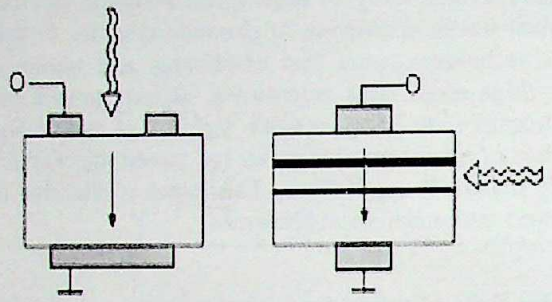
2. MICROWAVE PHOTONIC COMPONENTS

For high-speed operation electronic devices are usually scaled down with respect to the lateral dimensions in order to decrease the device capacitance and to decrease the RC time constant. A solution of this problem is the use of propagation effects, i.e. to employ wave propagation phenomena in the design of the electronic device as has been described in [7] and already used in the design of high-speed integrated circuits such as RFICs and MMICs (cf. Traveling wave amplifiers). Moreover, at high frequencies the packaging of high speed devices or circuits has basically to include wave propagation effects, for example the characteristic impedance of the electrical interconnect. Finally, the transit time and wave propagation effects of space charges have also to be regarded in the development of the high-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

speed device. In optics on the other hand, wave propagation is the Fundamental physical basis and no lumped elements exist up to now. As a consequence, the design of optical and photonic components usually includes optical waveguides and element dimensions large with respect to the wavelengths in optics.



(a) Horizontal (b) light wave propagation

Fig. 1: Microwave optical interaction devices with vertical (a) horizontal (b) and light wave propagation.

In microwave photonic components an interaction between electrons, electrical fields and photons take place which can be regarded as microwave-optical interactions (Figure1). Consequently, different technologies meet and may in a synergetic mixture – be merged in order to develop novel concepts with great advantages. A key example is the traveling wave (TW) device (Figure 2) where wave propagation effects in the electrical as well in the optical domain are utilized. The concept is based on the fundamentals of nonlinear optics where interaction takes place during wave propagation. Obviously, the bandwidths of these elements are not limited by RC time constant as shown in figure 3.

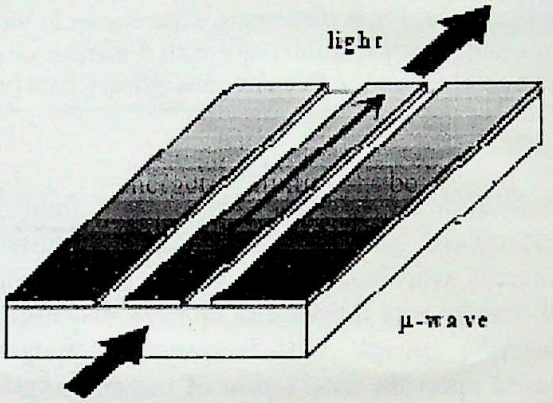


Fig.2: Traveling wave (TW) concept.

In an optoelectronic TW device [8,9] an optical waveguide is used for optical wave propagation and an electrical transmission line (e.g. micro strip or coplanar waveguide) for guiding the microwave, usually in the same direction.

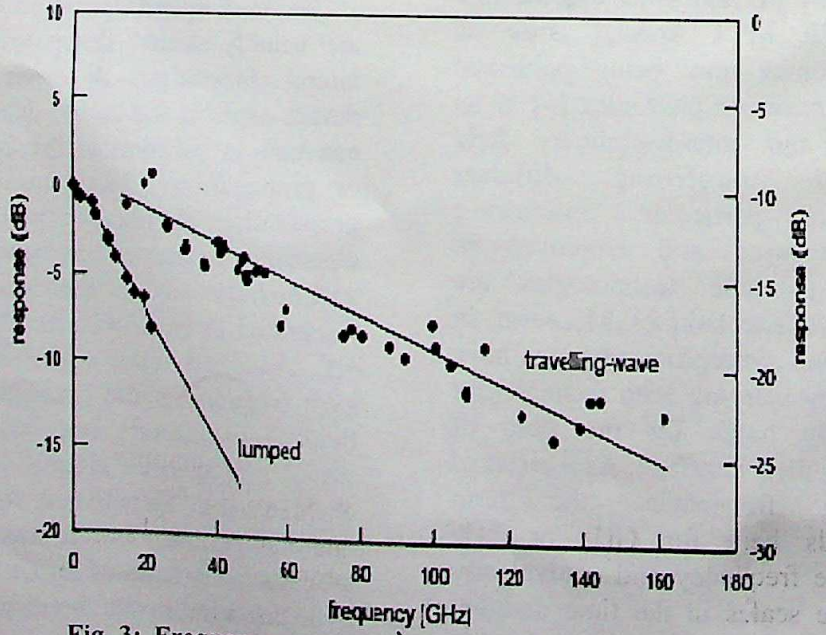


Fig. 3: Frequency response of a lumped and a TW device.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In the region where the electrical fields overlap, the optoelectronic interaction occurs. Note that a dc bias may additionally be applied to control the operating point. From a physical point of view the interaction is a nonlinear or active process. The photo detector and the laser diode are basic examples of two-port devices where optical power is converted into electrical power and vice versa. Typical three-port devices are electrically controlled optical modulators/switches or optically controlled microwave modulators/switches. Due to the inherent nonlinearity these devices are further used for optoelectronic mixing of input electrical and/or optical signals where the output signal can be electrical or optical. For next generation broadband photonic communication networks, the electro absorption modulator (EAM) will be a key element because it can be used also as an electro absorption detector (EAD). As a result, this element is a multifunctional device [8, 9] which has been called electro absorption transceiver (EAT) because of its applications in full-duplex optical communication links [10]. An EAT can further be used to generate artificial optical nonlinearities such as optical bistability [11] which gives rise to switching, logic and memory effects and may be useful for multiple-GHz A/D conversion. In figure 3, a comparison is made between a lumped EAM and a TW EAD with comparable cross sections. As can be seen, the lumped element exhibits a RC time constant corresponding to about 10 GHz whereas the TW device shows a clear response beyond 160 GHz. Obviously, the use of microwave technologies can drastically improve the bandwidth of such photonic devices.

3. BROADBAND FIBER OPTICAL LINKS

An analog optical link consists of an optical transmission medium (preferably a fiber) and optoelectronic converters on both sides [12]. The great advantage is that due to the broadband low-loss transmission capability the optical fiber as shown in figure 4, can ideally be used to transmit microwave signals and therefore replace other lossy metallic waveguides, e.g. X-band WG or coax. Here different techniques have been explored.

For example, on the transmitting side a CW laser diode and an external modulator (electro optic or EAM) and on the receiving side an optoelectronic photo detector can be used. Besides the bandwidth a key parameter of such a link is the link loss which depends on the conversion efficiencies of the optoelectronic elements, the optical coupling efficiencies and the attenuation and dispersion of the transmission medium [9,12]. Note that a link gain can easily be achieved when an optical amplifier (EDFA) and/or external modulators, preferably on both sides, are being used [9]. For high-speed and broadband operation the a.m. TW microwave photonic devices can successfully be employed.

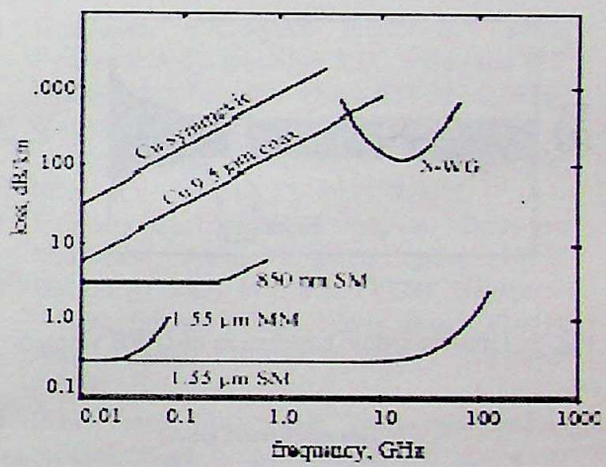


Fig. 4: Propagation loss of different transmission media, SM (single mode) and MM (multimode glass fiber).

For bidirectional communications, the link would require a duplication of the elements on both sides in order to provide uplink and downlink transmission. This is the conventional system architecture. In an advanced system the base station contains only one optoelectronic element, the transceiver, as realized by an EAT [10]. Given that due to the basic physical mechanisms the electrical bandwidth of the EAT is the same for the detection and the modulation process, a bandwidth of more than 160 GHz can be achieved using a TW EAT.

4. MICROWAVE PHOTONIC SYSTEMS

Broadband fiber optic links are regarded to be basic building blocks for different microwave systems.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

4.1 Photonic signal generation and local oscillators

Figure 5 shows the concept of UWB signal generation using a micro strip resonator with an optoelectronic switch as an RF mirror integrated with a broadband antenna [13-15]. Further, mixing two optical wavelengths from two frequency locked lasers or a two mode laser in a photo detector emulates a microwave local oscillator where the difference frequency is photonic ally generated by heterodyne techniques (figure 6) and where wavelength tuning provides a bandwidth of several THz depending on the bandwidth of the detector [16,17]

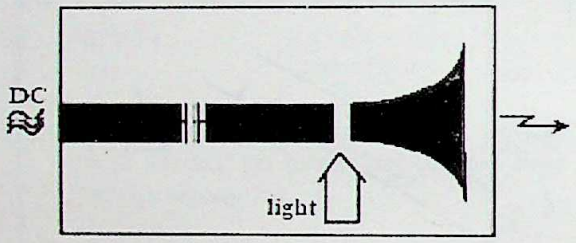


Fig. 5: Optoelectronic generation of UWB signals.

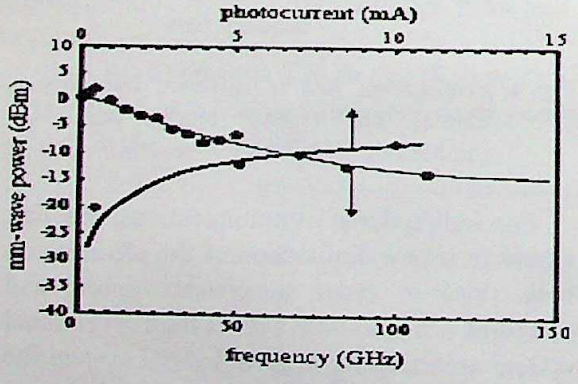


Fig. 6: Heterodyne RF generation using a TW-PD and generated power versus photocurrent at 110GHz.

4.2 EMC sensor

When the modulator at the end of a fiber is driven by an electrical input signal at the given position, the received optical signal can be used to measure the electrical signal quantitatively at the transmitter side and a field sensor results. Note that an electrical dc power required at the sensor side can also be transmitted optically by employing a photovoltaic cell at the receiver side [18].

4.3 Optoelectronic Testing

A microminia-turized modulator chip working in reflection mode and coupled to the end of a fiber can be applied to measure electrical fields in free space with high spatial resolution [19]. This is also the basic concept for contactless high-speed testing of integrated circuits, well-known as the electro optic sampling principle of figure 7 [20, 21].

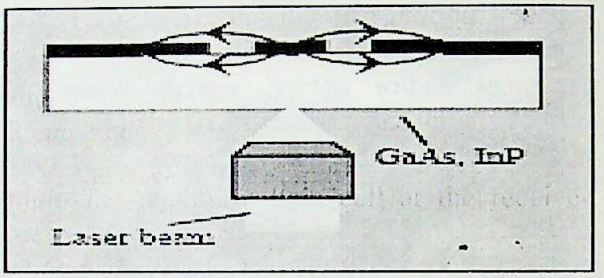


Fig. 7: Principle of electro optic sampling.

4.4 Hybrid fiber-coax systems

In cable TV (CATV) the signals received from TV satellites can be converted into the optical domain and fed into a fiber to be transmitted over long distances with only small attenuation. The optical signals being transmitted are converted back into the electrical domain and guided to the costumer via coaxial cable.

4.5 Fiber-radio systems

It is agreed that fiber-radio access [22] will provide a solution to the demands for a wireless connection to the costumer (last or first mile problem). For broadband services the frequencies are in the millimeter wave range. Such a concept is based upon an optical link between the central station (CS) and the base station (BS) in a pico cellular structure. Recently, 60 GHz fiber radio links have been demonstrated providing 155 Mbps using EAMs for half-duplex and EATs for full-duplex transmission in a WDM ring network [23]. Fig. 8 shows a novel architecture of a 60 GHz fiber-radio system using an EAT, (i) to generate the 57 GHz carrier frequency from LD1 and LD1' where LD1 is directly modulated by the downlink IF signal at 2.6 GHz, and (ii) to mix the photonic LO signal directly with the IF signal. LD2 provides the uplink signal to be modulated at the BS with the uplink signal.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

4.6 Antenna Systems

A major application of optical link technology is the remoting of antenna systems and, particularly, the optical control of array antennas [4,5]. A millimeter wave or THz camera with photonic interconnection is foreseen.

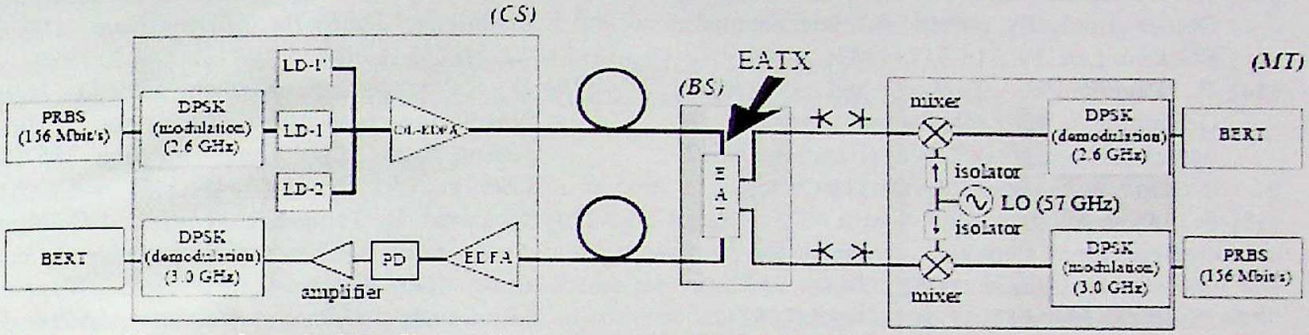


Fig. 8: Architecture for a 60 GHz fiber-radio access system [23]. LD denotes a laser diode, PD a photo detector, and EAT-X an EAT – mixer. MT is the mobile terminal.

5. CONCLUSION

In the past decade the field of microwave and millimeter wave photonics has become a key technology extending from components and modules to systems with important applications. The driver has been twofold: On one hand the broadband low-loss and high-speed transmission capability of optical fibers has led to a considerable interest in their use for distributing and controlling micro-and millimeter wave signals. On the other hand the breakthrough in the design and demonstration of several ultra-broadband photonic components has paved the way for wideband and high efficiency optoelectronic converters being important building blocks for microwave optical links. As a result, it can be foreseen that this multidisciplinary field of microwave photonics will continuously be expanded and lead to further novel concepts due to the synergetic merging of different technologies as has been done similarly in the area of MEMS.

ACKNOWLEDGEMENT

The author wishes to thank Prof. Deric Engles, Department of Electronics Technology, GNDU Amritsar for his valuable suggestions.

REFERENCES

[1] D. Jäger, Traveling-Wave Optoelectronic Devices for Microwave and Optical Applications, *Proc. of Progress in Electromagnetic Research Symposium [PIERS]*, 327, 1991.

[2] D. Jäger, Microwave Photonics, *Optical Information Technology,* S.D. Smith and R.F. Neale [Eds.], *Springer Press*, 328-333 (1993).

[3] D. Polifko and H. Ogawa, The Merging of Photonic and Microwave Technologies, *Microwave Journal*, 75- 80 (1992).

[4] International Topical Meeting on Microwave Photonics, Techn. Digest, Kyoto (1996), Duisburg (1997), Princeton (1998), Melbourne (1999), Oxford (2000), Long Beach (2001), Awaji (2002), Budapest (2003), Ogunquit (2004).

[5] IEEE Trans. Microwave Theory and Techn., Special Issues on Microwave and Millimeter Wave Photonics, Sept. 1995, Sept. 1997, July 1999, Dec. 2001, and *IEEE J. Lightw. Techn.*, 2003.

[6] A. Vilcot, B. Cabon, and J. Chazelas (Eds), *Microwave Photonics,* Kluwer, 2003.

[7] D. Jäger, Characteristics of traveling waves along nonlinear transmission lines for monolithic integrated circuits- A review, *Int. J. Electron.* 58, 649- 669 (1985).

[8] D. Jäger, R. Kremer, and A. Stöhr, Traveling wave optoelectronic devices for microwave applications, *IEEE Int. Microw. Symp. Digest* 1, 163-166 (1995).

[9] D. Jäger, A. Stöhr, and R. Heinzelmann, Advanced microwave photonic devices for analog optical links, *Int. Top. Meet. Microwave Photonics, Techn. Digest, Princeton*, 153-156 (1998).

[10] K. Kitayama, A. Stöhr, T. Kuri, R. Heinemann, D. Jäger, and Y. Takahashi, An approach to single optical component antenna base stations for broadband millimeter wave fiber-radio access systems, *IEEE Trans. Microw. Th. Techn* 48, 2588-2595 (2000).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

[11] D. Jäger, Large optical nonlinearities in hybrid semiconductor devices, *J. Opt. Soc. Am. B* (6), 588-594 (1989).

[12] C. Cox, III, *Analog Optical Links*, Cambridge, 2004.

[13] R. Heidemann,Th. Pfeiffer, and D. Jäger, Optoelectronically pulsed slot line antennas, *Electron. Lett.* 19, 316-317 (1983).

[14] P. Paulus, W. Brinker, and D. Jäger, Generation of microwave pulses by optoelectronically switched resonators, *IEEE J. Quantum Electron.* 22, 108-111 (1986).

[15] P. Paulus, L. Stoll, and D. Jäger, Optoelectronic pulse compression of microwave signals, *IEEE Trans. Microw. Theory Techn.* MTT-35, 1014-1018 (1987).

[16] A. Stöhr, R. Heinzelmann, K. Hagedorn, R. Güsten, F. Schäfer, H. Stüer, F. Siebe, P. van der Wal, V. Krozer, M. Feiginov and D. Jäger, Integrated 460 GHz photonic transmitter module, *Electr. Lett,* 37 (22), 1347-1348 (2001).

[17] A. Malcoci, A. Stöhr, A. Sauerwald, S. Schulz, D. Jäger, Waveguide and antenna coupled traveling-wave 1.55-μm photodetectors for optical (sub) millimeter-wave generation, in *Proc. SPIE Photonics Europe, Microwave and Terahertz Photonics, Strasbourg*, 202-209 (2004).

[18] R. Heinzelmann, A. Stöhr, M. Groß, D. Kalinowski, T. Alder, M. Schmidt, and D. Jäger, Optically powered remote optical field sensor system using an electrabsorption modulator, *IEEE Int Microw.Symp. Digest,* 1225-1228 (1998).

[19] D. Kalinowski, S. Redlich, and D. Jäger, Novel micromachined fiber-optic E-field sensor, *Proc. LEOS Annual Meeting,* 385-386 (1999).

[20] G. David, R. Tempel, I. Wolff, and D. Jäger, Analysis of Microwave Propagation Effects using 2D Electro-Optic Field Mapping techniques, *Optical Quantum Electron., Special Issue*, 919-931 (1996).

[21] G. David, P. Bussek, U. Auer, F. J. Tegude, and D. Jäger, Electro-Optic Probing of RF-Signals in Sub-μm MMIC Devices, *Electron. Lett.* 31(25), 2188-2189 (1995).

[22] H. Al-Raweshidy and S. Komaki (Eds), Radio Over Fiber Technologies, *Artech House,* 2002.

[23] Stöhr, T. Kuri, K. Kitayama, R. Heinzelmann, and D. Jäger, Full-Duplex 60GHz fiber optic transmission, *Electron. Lett.* 35 (19), 1653-1655 (1999).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.41-46 (2011)

BER Simulation of OFDM Signal under AWGN and Rayleigh Fading Environment

Arun Shekhar Bahuguna[1#], Gaurav Malik[2] and Vivek Kumar[2]
[1]*Shivalik College of Engineering, Dehradun, India*
[2]*Gurukul Kangri University, Haridwar, India*
[#]Corresponding author (**Email:** arunshekharb@indiatimes.com)

ABSTRACT- OFDM is a special case that can be seen as either a modulation technique or a multiplexing technique. A large number of closely-spaced orthogonal sub-carriers are used to carry data. The data is divided into several parallel data streams or channels, one for each sub-carrier. Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase shift keying) at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth. In the present paper study and identification of the OFDM technology that gives the best BER performance in a multipath fading environment using simulation has been carried out. Orthogonal Frequency Division Multiplexing is modeled and simulated under different channel conditions such as AWGN and Rayleigh fading. Subsequently, a comparison study is carried out to obtain the BER performance for OFDM under 1-path multipath fading conditions and to identify which channel gives the best BER performance. The comparison study showed that BER for AWGN channel gives the best BER performance compared to Rayleigh channel.

KEYWORDS: OFDM, BER, FFT, QPSK, S/N.

1. INTRODUCTION

The Bit Error Rate (BER)[1] for orthogonal frequency division multiplexing (OFDM) under different channels condition is an important parameter in digital communication. Digital multimedia applications as they are getting common lately create an ever increasing demand for broadband communications systems. OFDM has grown to be the most popular communications system in high speed communications in the last decade. In fact, it has been said by many industry leaders that OFDM technology [2] is the future of wireless communications. The identification of Orthogonal Frequency Division Multiplexing technology that gives the best BER performance under AWGN [3] & Fading channel environment using simulation is reported in the following sections.

2. OFDM-BER CONFIGURATION USING MATLAB SIMULATION

This paper does not explain in detail the simulation code. It uses it to create results and see the behavior of OFDM-BER under AWGN & Rayleigh channel properties. The Matlab code used is in the present work. This implementation is used to transmit a computer file in binary data form modulated by OFDM and QPSK [4] modulation (figure 1). Scheme of every part of the implementation done in

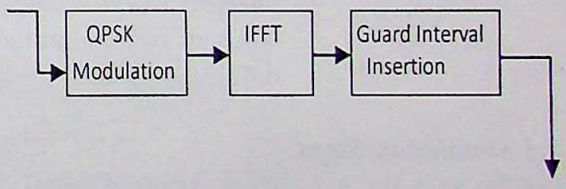


Fig. 1: Implementation to transmit a computer file in binary data form modulated by QPSK.

Matlab and channel imperfections are modeled in this implementation. In the end of the transmission, when the receiver receives the data, a comparison of the transmitted and the received messages is done in order to calculate the Bit Error Ratio (BER).

The binary data to be transmitted is differentially encoded using a QPSK modulation scheme, obtaining a sequence of complex data symbols. In this one symbol consist of 2 bits. There are two possibilities to

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

perform differential modulation in the presented OFDM scheme. Data can be encoded in the relative phase of adjacent symbols in each sub channel (correspondent samples in two consecutive OFDM symbols) or in the relative phase of samples transmitted in adjacent sub channels, that is consecutive samples of an OFDM symbol. Since the IFFT block accepts N parallel samples to its entry. If the modulation is made on the serial stream, prior to the parallel conversion required by IFFT, then an in-frame modulation is chosen, since N consecutive serial samples will simultaneously modulate N orthogonal carriers, forming an OFDM symbol. The parameter for the simulation has been defined as follows:

```
parach = 128 ; % Number of parallel
                 channel
fftlen = 128;  % FFT length
noc =128;      % Number of carrier
nd = 6;        % Number of OFDM
                 symbol
                 for one loop
ml = 2;        % Modulation level :
                 QPSK
smr = 250000; % Symbol rate
br = sr.*ml;   % Bit rate per carrier
gilen = 32;    % Length of guard interval
ebn0 = 100;    % ebn0 : Eb/No
nloop = 100;   % Number of simulation
                 loops
noe = 0;       % Number of error data
nod = 0;       % Number of transmitted
                 data
```

2.1 Simulation Steps

(a) To start the simulation, random serial data of 0 and 1 are generated consisting of 1-by-para*nd*ml vector. This vector is called as "serialdata". We can generate this by rand function.

(b) Then, the serial data vector,"serialdata" was converted into a parallel data vector, "parallel data", consistiong of a para-by-nd*ml vector to transmit the data in parallel in order to enable parallel transmission with 128 subchannels where each channel was using a QPSK modulation scheme.

(c) After that the vector "parallel data" was fed into the mapping circuit. In the circuit, the parallel data were converted into modulated parallel data of two channels, Ich and Qch by a predefined mapping method

(d) After the mapping, these parallel data on the frequency axis were fed into the IFFT circuit. In this circuit, the parallel data were converted into serial data on the time axis by using OFDM and after that guard interval were inserted to eliminate ISI caused by multipath fading.

(e) At the receiver, the received signal was first contaminated by AWGN and Fading environment. The noise function for AWGN was introduced as a function comb.m and for Rayleigh fading as sefade.m. In this simulation, the variable "attn" will vary in accordance with given Eb/No.

(f) By using "attn" and comb.m, the transmitted data was contaminated by AWGN and then, the guard interval was removed from received signal.

(g) After that signal were fed into the FFT circuit. In this circuit, the serial data were converted into parallel data on the frequency axis and the demodulated data were converted into a 1-by-para*nd*ml vector.

(h) Hence cumulative number of errors and data bits in noe and nod are given by

noe = noe +noe2;

nod=nod+nod2;

and BER under different communication channel can be obtained using the following operation:

ber = noe/nod

3. RESULTS AND DISCUSSIONS

3.1 OFDM under AWGN channel

Under this condition, the BER performance of OFDM under AWGN channels are simulated two times. One for theoretically and another is with matlab code simulation.

3.1.1 OFDM under AWGN channel (theoretical)

OFDM has been simulated under AWGN channel which is known as the ideal communication channel. Figure 2 shows the result of the theoretical AWGN.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

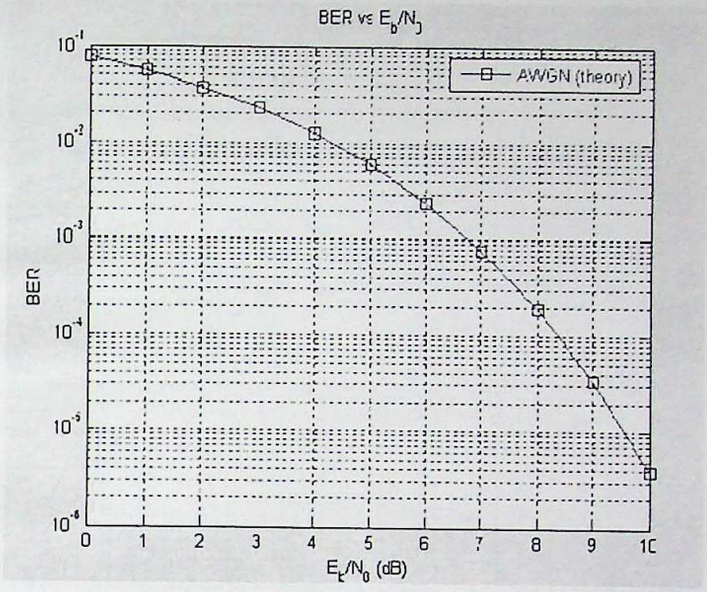


Fig. 2: BER analysis of theoretical AWGN

3.1.2 OFDM under AWGN channel after Matlab simulation

The BER vs Eb/No plot in figure 3 shows the result of OFDM under AWGN channel after the simulation.

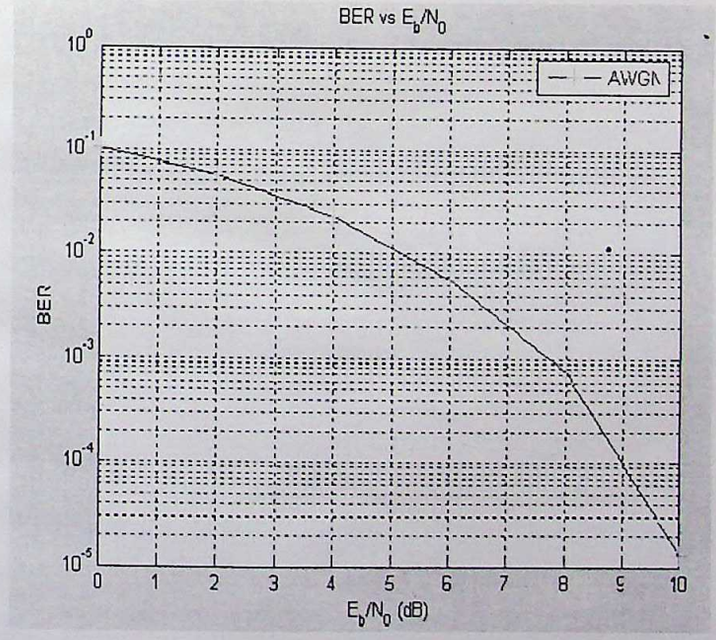


Fig. 3: BER analysis of AWGN after matlab simulation

3.1.3 Comparison of OFDM-BER under AWGN channel theory and simulation

The result shows that AWGN under simulation gives 0.9691 db shifts from the theoretical value. This shift was caused by the cutting off of the guard interval power from the received signal (Figure 4).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

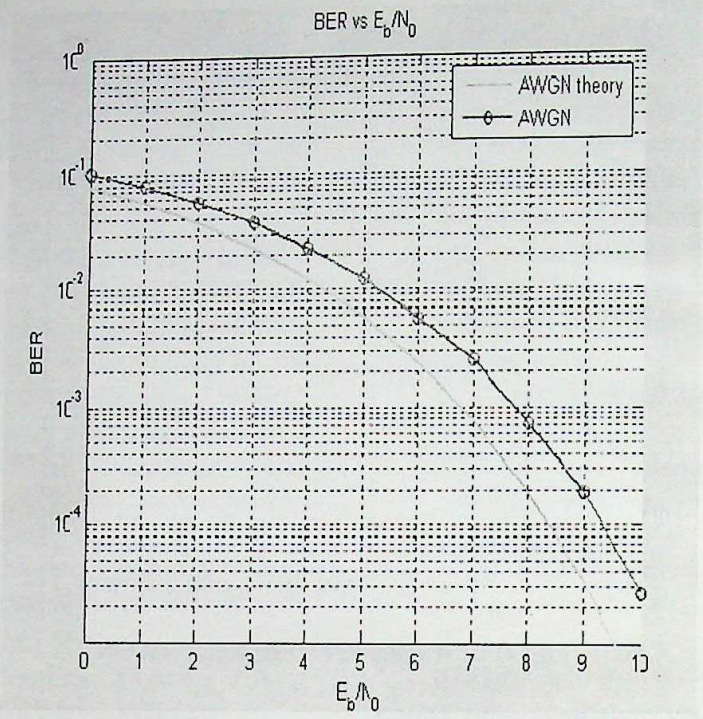


Fig. 4: Comparison of BER between AWGN theory and simulation

The shift value(db) can be obtained by Shift value (dB) = Received signal power – Guard interval power

3.1.4 OFDM under one path Rayleigh fading (Theory)

Figure 5 shows the result of OFDM one path Rayleigh fading theoretically

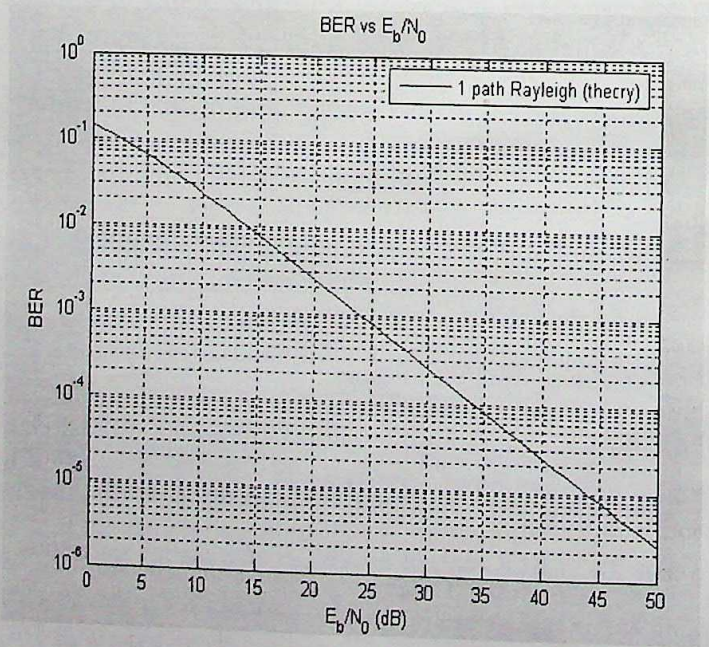


Fig. 5: BER analysis of OFDM under one path Rayleigh (Theory)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

3.1.5 OFDM under one path Rayleigh after simulation

After designing and running the matlab code, the BER vs Eb/No graph can be obtained under one path Rayleigh as shown in figure 6.

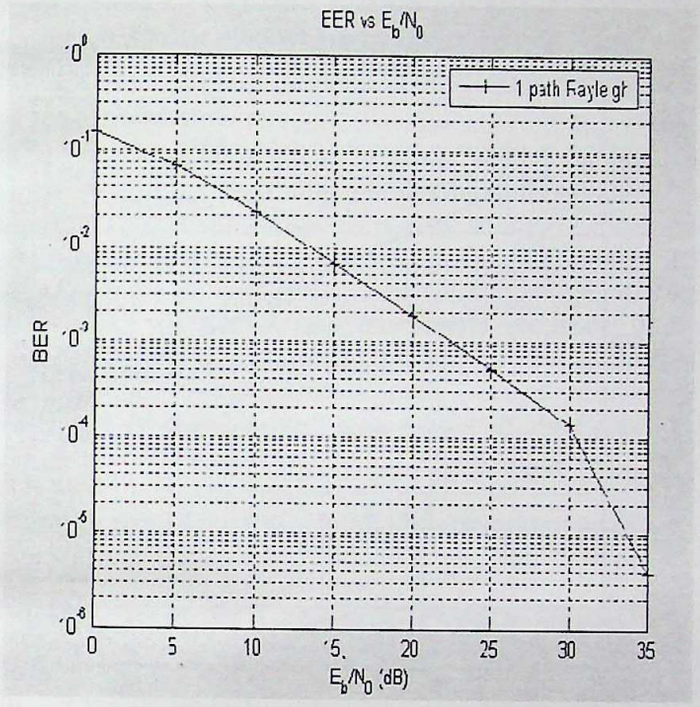


Fig. 6: BER analysis of OFDM under one path Rayleigh after simulation

3.1.6 Comparison of BER between one path Rayleigh theory and simulation

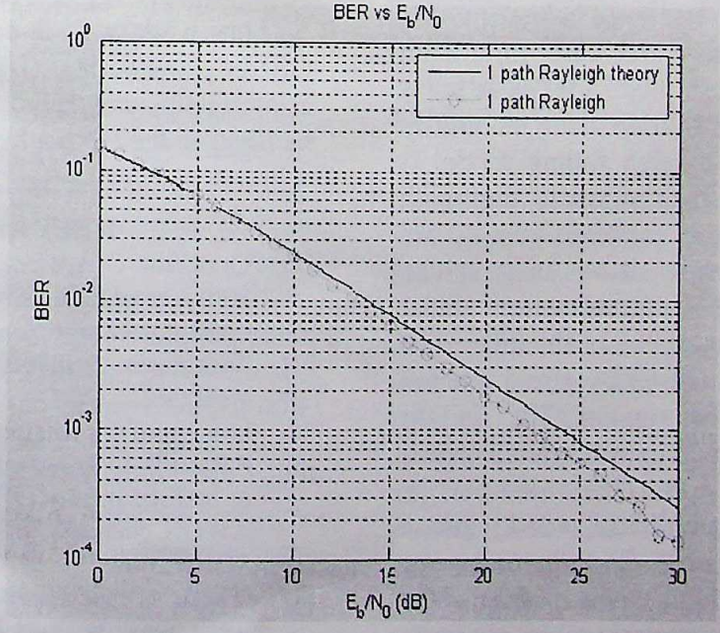


Fig. 7: Comparison OFDM under one path Rayleigh between theory and simulation

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Figure 7 shows the Comparison OFDM under one path Rayleigh between theory and simulation. From the BER performance under one path Rayleigh fading, it shows that if we can compensate for the amplitude and phase fluctuations caused by fading perfectly, 0.9691 dB shifted can be obtained from the theoretical value.

3.1.7 OFDM-BER Comparison under two different channels: AWGN and One Path Rayleigh Fading

Figure 8 shows the performance for both communication channels.

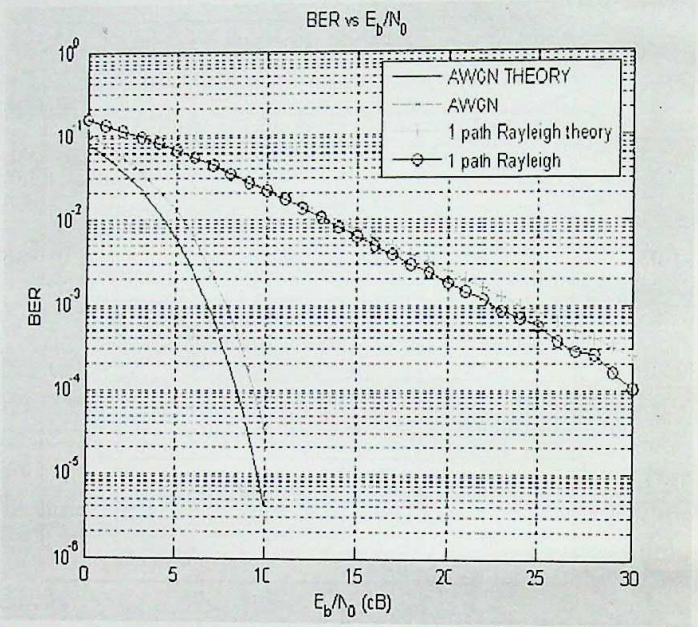


Fig. 8: OFDM-BER Comparison between AWGN and One Path Rayleigh fading.

4. CONCLUSION

In order to achieve the objectives of this paper, first, the concept of Orthogonal Frequency Division Multiplexing (OFDM) is studied. Then, communication channel models for ideal AWGN and worst case (multipath fading) channels were studied. AWGN is fairly simple to implement in Matlab using its built-in function. After that Rayleigh fading model is implemented in Matlab to simulate multipath fading channel. All the expected results are obtained. From the results, it has been shown that the OFDM BER performance under AWGN channel gives 0.9691 db shift. The shift of the value was caused by guard interval power for the received signals. The OFDM BER performance for one path Rayleigh fading also gives 0.9691dB shift. This value can be obtained if the amplitude and phase fluctuations caused by fading can be compensated perfectly. Lastly, from the simulations, AWGN communications channels give the best ideal communication as compared to one path Rayleigh fading.

5. ACKNOWLEDGEMENT

This work was done in the DSP Lab. of GBPEC, Pauri (Uttarakhand). Authors acknowledge the Head of the DSP Lab. for facilitating the lab. and valuable discussions.

REFERENCES

[1] Orlandos Grigoriadis, H. Srikanth Kamath, BER calculation using MATLAB simulation for OFDM transmission.

[2] Wikipedia, free encyclopedia, article on bit error rate http://en.wikipedia.org/wiki/Bit_error_rate.

[3] P.Banelli & S.Cacopardi. Theoretical analysis & performance of OFDM signals in non-linear AWGN channels, *IEEE Trans. Comm.* 48 (3), March 2000.

[4] Thesis of Eric Lawrey on OFDM modulation technique for wireless radio applications, October 1997.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS
J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.47-51 (2011)

Synthesis, Structural and Electrical Characterization of $SrTiO_3$ Thin Films Prepared by Sol- Gel Method

Trilok Kumar Pathak[1], Prabha Singh[2], Hemendra Tripathi[1] and L.P.Purohit[1#]
[1]*Department of Physics, Gurukula Kangri Univesity, Haridwar, India*
[2]*Vira College of Engineering, Bijnor(U.P.), India*
[#]Corresponding author (**Email**: lppurohit@gmail.com)

ABSTRACT- Polycrystalline $SrTiO_3$ thin films having a cubic perovskite structure were synthesized on platinum-coated silicon substrate. Crystalline films with uniform composition and thickness were prepared by spin-coating and the post-deposition heat treatment was carried out at different temperatures. The film showed good structural, dielectric and insulating properties. Scanning electron microscopy (SEM) micrographs showed no occurrence of inter diffusion between the bottom electrode (platinum) and the film during post-annealing, indicating a stable interface between the $SrTiO_3$ and the bottom electrode. The dielectric constant and dissipation factor at a frequency of 100 kHz were 250 and 0.01 respectively for a 360 nm thick film annealed at 600^0C. The capacitance versus applied voltage characteristics showed that the capacitance was almost independent of the applied voltage. I -V characteristics were Ohmic in low fields and a Schottky emission or Poole-Frenkel emission were postulated in high fields.

KEYWORDS: Spin coating, $SrTiO_3$ thin films, XRD, SEM, Dielectric properties.

1. INTRODUCTION

Ferroelectric thin films have been investigated in recent years for application in memory cell capacitors for nonvolatile memories or dynamic random access memories (DRAMs) [1,2]. Spontaneous polarization and its reversibility by an applied electric field are unnecessary for DRAMs, although a high dielectric constant with low leakage current is required. Among numerous ferroelectric materials, paraelectric strontium titanate ($SrTiO_3$) a cubic perovskite-type crystal, has attracted particular attention for dynamic random access memories (DRAM) because of its high dielectric constant and good thermal stability and high compatibility with device processes [3,4]. Many investigators have studied deposition methods for these thin films and their electric properties. $SrTiO_3$ films have been prepared using sputtering, pulsed laser deposition, reactive co-evaporation, and metallo-organic deposition (MOD) [5-7]. However, these methods require a high deposition or post annealing temperature. On the other hand, polymeric precursor method-derived thin films [8] are very attractive candidates for a variety of new applications in microelectronics, e.g. DRAMs. Despite this fact, few reports have been published on the preparation of $SrTiO_3$ by the polymeric application in dielectrics precursor method [9]. The main advantage of this method is the easy production of pure, homogeneous, stoichiometric ceramic thin films that usually become polycrystalline at relatively lower temperatures than with other methods. This work, which consisted of the examination of $SrTiO_3$ thin films deposited by the polymeric precursor method at different temperatures, resulted in 360 nm- thick SrTiO3 film with a high dielectric constant, low leakage current, and high dielectric breakdown strength.

2. EXPERIMENTAL DETAILS

Figure 1 outlines the flow chart of the $SrTiO_3$ synthesis used in this study. Titanium citrates were formed by dissolution of titanium isopropoxide in an aqueous solution of citric acid ($60\text{-}70^0$C). After homogenization of the Ti solution, $SrCO_3$ was slowly added and, after complete dissolution of the $SrCO_3$ salt, ethylene glycol was added to promote polymerization of the mixed citrates by a polyesterfication reaction.

Platinum-coated silicon was used as the substrate, which was spin-coated by dropping a small amount of the polymeric precursor

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

solution onto it. Rotation speed and spin time were fixed at 4500 rpm and 30 s, respectively. After deposition, each layer was dried at 120^{0}C on a hot plate for 20 min to remove residual solvents. The heat treatment was carried out in two stages: initial heating at 400^{0}C for 2 h at a heating rate of 5^{0}C/ min to pyrolyze the organic materials, followed soon thereafter by heating at different temperatures for 2 h to crystallize them. Film thickness was controlled by adjusting the number of coats and each layer was pyrolyzed at 400^{0}C and crystallized at different temperatures before the next layer was deposited.

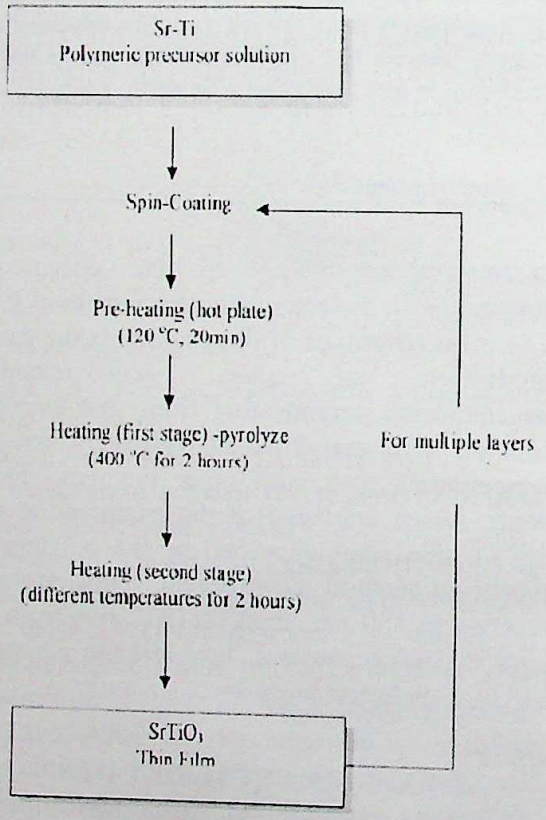


Fig. 1: Flow chart for polymeric precursor processing of $SrTiO_3$ thin film.

The $SrTiO_3$ films were structurally characterized by X-ray diffraction (XRD) (Cu K_α radiation) and the diffraction patterns recorded on a Siemens D5000 machine in a [θ-2θ] configurations, using a graphite monochromator. Film thickness was measured by a thin film cross-section analysis made by SEM (Zeiss, DSM940A).

For the electrical measurements, 0.3 mm diameter gold electrodes were deposited by sputtering through a designed mask onto the film surfaces to form metal-insulator-metal capacitors (MIM). The dielectric properties were measured as a function of frequency using a Hewlett-Packard (4194A) impedance/gain phase analyzer.

The capacitance versus applied voltage characteristic was measured in the MIM configuration using a small AC signal of 10 mV at 100 kHz. The signal was applied across the sample, while the DC electric field was swept from positive bias to negative bias and back to positive bias (C-V curves). Dielectric constant and dissipation factor values were measured at a frequency range of 100 Hz-10 MHz in 360-nm-thick films. I-V characteristics were measured with a Keithley 237 electrometer/source. All the measurements were taken at room temperature.

3. RESULTS AND DISCUSSION

Figure 2 shows the X-ray diffraction patterns of polymeric precursor method-grown $SrTiO_3$ thin film deposited on platinum-coated silicon substrate and annealed at different temperatures for 2 h. A diffuse XRD pattern is observed at 400 and 450^{0}C, indicating the formation of an inorganic amorphous precursor after the pyrolysis process. For temperatures higher than 450^{0}C, starts the crystallization of the $SrTiO_3$ perovskite phase. No intermediate phase was observed which suggests a direct crystallization from the amorphous phase. This type of transformation was reported by Okumada and Komatsu [10] for $SrTiO_3$ films prepared by the sol-gel method. However, crystalline structure patterns were identified in the films heat treated above 600^{0}C.

Similar results also were reported by Leite [11] for $Ba_{1-x}Sr_xTiO_3$ (BST) thin films prepared by Pechini process, where the characterization of these films showed that BST phase crystallizes at 600^{0}C from an inorganic amorphous matrix and no intermediate crystalline phase was observed. The diffractogram reveals well defined peaks showing a good deal of crystallinity. The intensities of the peaks agree very well with those given in ASTM data cards (#5-634) for

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

SrTiO3, suggesting that the film was polycrystalline. All the peaks are ascribed to a cubic perovskite structure having a=b=c = 3.90 Å lattice.

Figure 3 shows the SEM image of a cross-section and the surface of the $SrTiO_3$ film prepared at 600°C. $SrTiO_3$ Film thickness was 360 nm, each layer displaying a very dense, uniform and sharp interface as well as a granular fine grain microstructure. No interdiffusion between the platinum layer and the $SrTiO_3$ layer was observed in the SEM images.

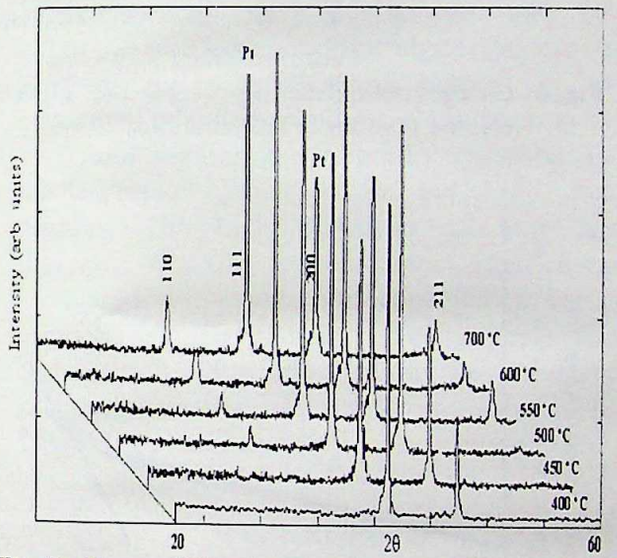


Fig. 2: X-ray diffraction patterns of $SrTiO_3$ thin films annealed at different temperatures.

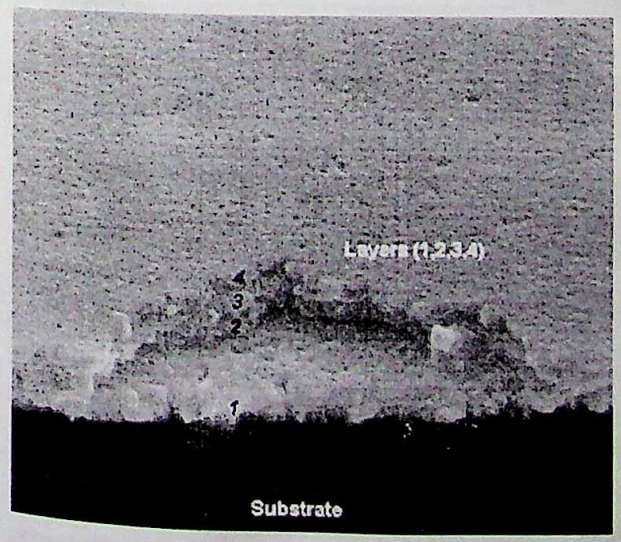


Fig. 3: SEM micrograph of surface morphology of $SrTiO_3$ Film

Figure 4 gives the variation of the dielectric constant and dissipation factor (tan δ) as a function of applied frequency. The dielectric constant displays an approximate decline of 13% with increasing applied frequency from 100 Hz to 1 MHz, a much lower value than the 30% decrease reported by Rao and Krupanidhi for $SrTiO_3$ Films grown by pulsed excimer laser [12]. As shown in figure 4, the dielectric constant and dissipation factor for a 360 nm film at a frequency of 100 kHz were 250 and 0.01, respectively. The dielectric constant at a frequency of 1 MHz was 241, higher value than those reported by Nam and Kim [13] for films deposited by sputtering and by Thomas [14] for films prepared by sol-gel method, which showed lower dielectric constants of 140 and 105 at 1 MHz, respectively. In other work $SrTiO_3$ films prepared by sol-gel method23 and annealed at 700°C showed a dielectric constant of 131 at a frequency 1 kHz.

The capacitance of the Film, shown in figure 4, was measured against a dc bias at 100 kHz. There was no appreciable change in capacitance with applied voltage. This result indicated the para electric properties of $SrTiO_3$ thin film at room temperature. Thus, the film shows good properties for dynamic random memory (DRAM) applications, which requires a flat dependence of capacitance on applied voltage.

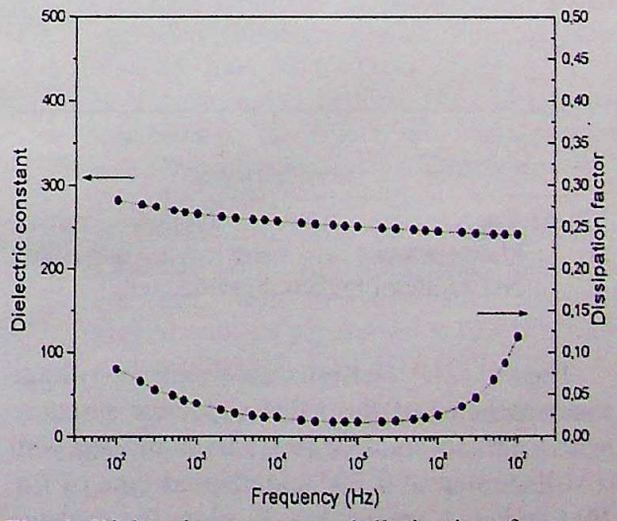


Fig. 4: Dielectric constant and dissipation factor as a function of applied frequency for $SrTiO_3$ thin film heat treated at 600°C.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Dielectric material for DRAM applications should, however, have a high charge storage density and a low current leakage density. The charge storage density of $SrTiO_3$ thin film was estimated from the capacitance-voltage characteristics shown in figure 5, using the relationship:

$$Q_c = \varepsilon_o \varepsilon_r E$$

Where, E is the applied electric field, ε_o is the free space permittivity, and ε_r is the dielectric constant calculated for the SrTiO3 film shown in figure 4. Figure 6 shows the variation of charge storage density of SrTiO3 films with applied electric field, where one can observe a linear relationship between the applied electric field and the charge storage density. This behavior is similar to other linear dielectrics. The charge storage density was estimated at 36 fC/mm^2 in an applied field of 100 kV/cm.

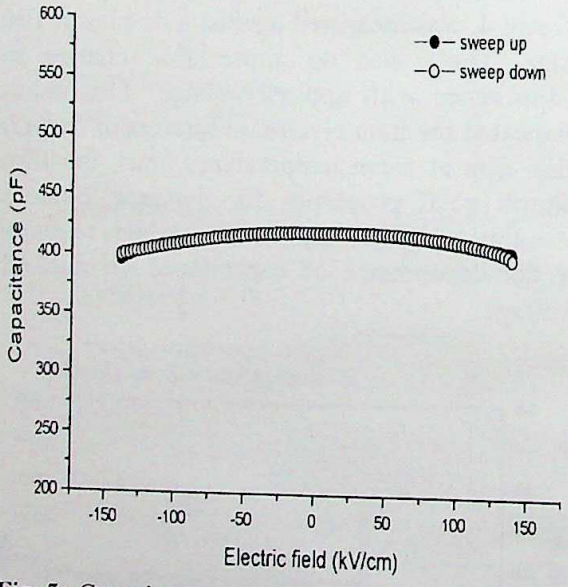


Fig. 5: Capacitance versus applied voltage characteristics of paraelectric thin film. $SrTiO_3$ thin film heat treated at 600^{0}C.

Figure 7 shows the current-voltage characteristics of the MIM capacitor structure with a 360 nm thick $SrTiO_3$ film measured with a voltage step of 0.1 V and elapsed time of 1 s. In the log J versus log E plot, the leakage current density increases linearly with the external electric field in the region of the

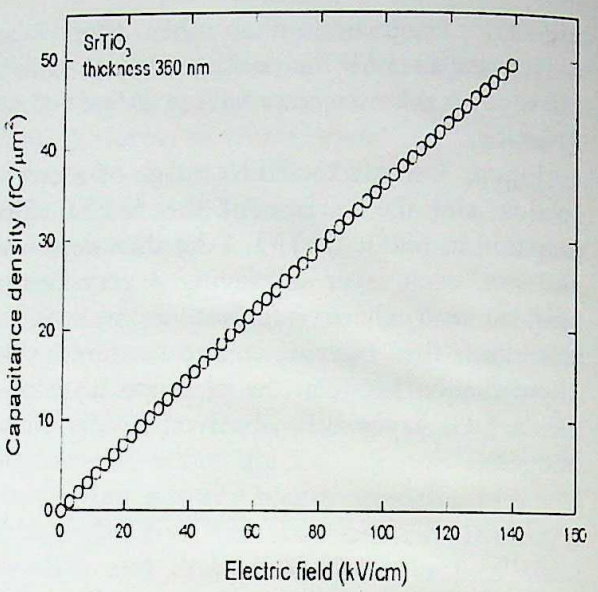


Fig. 6: Charge storage density versus the applied electric field for $SrTiO_3$ thin film.

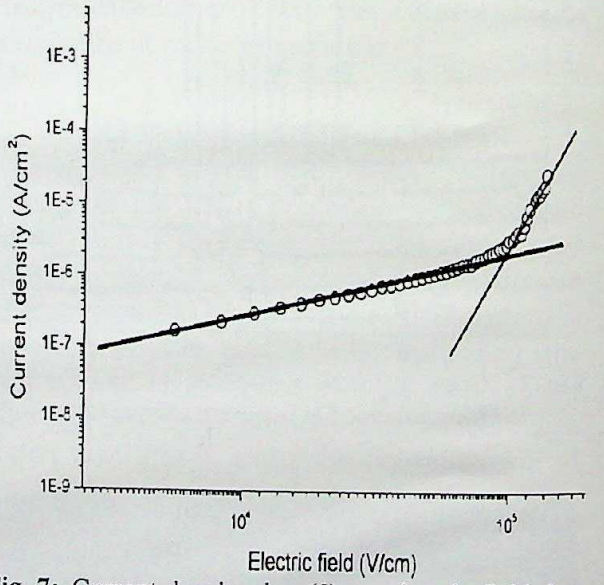


Fig. 7: Current density, log (J) vs. electric field, log (E) curve for $SrTiO_3$ thin film prepared by the polymeric precursor method.

low electric field, with a slope of about 0.88, indicating an ohmic like conduction mechanism. Above a critical field, the leakage current density increases non- linearly since the current conduction is governed by another emission mechanism. In the high field region, the log(J) *vs* log(E) curve presents a slope higher than 6. The leakage current level of the $SrTiO_3$ film obtained by the polymeric precursor method was about of 10^{-7} A/cm^2 at an applied electric field of 100 kV/cm.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

4. CONCLUSION

Polycrystalline $SrTiO_3$ thin films were prepared by the polymeric precursor method on $Pt/Ti/SiO_2/Si$ substrates at different temperatures. The $SrTiO_3$ thin films prepared at 600^0C consisted of fine grains of approximately 60 nm, with a thickness of 360 nm. SEM micrographs showed no interdiffusion between the bottom electrode and $SrTiO_3$ thin film during heat treatment at 600^0C, indicating a stable interface between $SrTiO_3$ and Pt. A dielectric constant of 250 and a low dissipation factor of 0.01 were observed at a frequency 100 kHz. The charge storage density and leakage current density were 36 fC/mm^2 and 10^{-7} A/cm^2, in an electric field of about 100 kV/cm. Further studies of leakage current of the capacitor indicated an ohmic conduction in the low field regions and Schottky emission and Poole-Frenkel emission in the high field regions. The high dielectric constant, low dielectric loss (dissipation factor), high charge storage density and good capacitance versus applied voltage characteristics suggest that $SrTiO_3$ thin films prepared by the polymeric precursor method are attractive material for DRAM applications.

REFERENCES

[1] D. Bao, Wu, X., Zhang, and Yao, X., Preparation, electrical and optical properties of $(Pb,Ca)TiO_3$ thin films using a modified sol-gel technique, *Thin Solid Films* 350, 30-37 (1999).

[2] S. Xiong, Migita,. Ota, and Sakai, Pulsed laser deposition and ferroelectric properties of $SrBi_2Ta_2O_9$ thin films, *Mater. Lett* 38, 406-412 (1999).

[3] C. L.Jia, K. Urban., S. Hoffmann. and R. Waser., Micro- structure of columnar-grained $SrTiO_3$ and $BaTiO_3$ thin films prepared by chemical solution deposition, *J. Mater. Res* 13, 2206-2217 (1998).

[4] M. Shibuya, M. Nishitsuji, T. Kitagawa, Kamada, A. Haya- shi, S. Tamura and Hirao, Substrate potential effects on low-temperature preparation of $SrTiO_3$ thin films by RF magnetron sputtering, *Jpn. J. Appl. Phys* 32, L1830- L1833 (1993).

[5] T. Yu, Y. Chen, Z. Liu, Ming, and Wu, Epitaxial growth of dielectric $SrTiO_3$ thin films by pulsed laser Deposition, *Appl. Surf. Sci.* 139, 605-608 (1999).

[6] Matsubara Yamaguchi and Miyasaka, Reactive co-evaporation synthesis and characterization of $SrTiO_3$ thin films, *Jpn. J. Appl. Phys* 30, 2197-2199 (1991).

[7] P.C. Joshi, and S. B Krupanidhi, Structural and electrical characteristics of $SrTiO_3$ thin films for dynamic random access memory applications, *J. Appl. Phys* 73, 7627-7634 (1993).

[8] F. M. Pontes, E. R. Leite, E. Longo, J. A. Varela and J. A. Eiras, Effects of the postannealing atmosphere on the dielectric properties of $(Ba,Sr)TiO_3$ capacitors: Evidence of an interfacial space charge layer, *Appl. Phys. Lett.*76, 2433-2435 (2000).

[9] S. M. Zanetti, E. Longo, J. A. Varela, and E. R. Leite, Micro- structure and phase evolution of $SrTiO_3$ thin films on Si prepared by the use of polymeric precursors, *Mater. Lett* 31, 173-178 (1997).

[10] K.Okuwada, and S. Komatsu, Preparation of SrTiO3 films by the sol-gel method, J. Ceram. *Soc. of Japan, Int. Edition* 100, 1070-1072 (1992).

[11] F. M. Pontes, E. Longo, J. H. Rangel, Bernardi, and J.A. Varela, $Ba_{1-x}Sr_xTiO_3$ thin films by polymeric precursor method, *Mater. Lett.* 43, 249-253 (2000).

[12] G. M. Rao, and S. B. Krupanidhi, Study of electrical properties of pulsed excimer laser deposited strontium titanate films, *J. Appl. Phys* 75, 2604-2611(1994).

[13] S. H. Nam, and H. G. Kim, The effect of heat-treatment on the $SrTiO_3$ thin films prepared radio-frequency magnetron sputtering, *J. Appl. Phys* 72, 2895-2899 (1992).

[14] R. Thomas, D.C. Dube, M.N. Kamalasanan, S. Chandra, and A. S Bhalla, Structural, electrical, and low-temperature dielectric properties of sol-gel derived $SrTiO_3$ thin films, *J. Appl. Phys* 82, 4484-4488 (1997).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS J. Nat. & Phys. Sc.
Vol. 24, No.1, pp.53-62 (2011)

CMOS Based Voltage Controlled Oscillator as an Application in Biomedical (Pace Maker)

Virender Sharma[1] and Vikram Verma[2]
[1]*Department of Electronics & Communication Engineering, JMIT, Radaur (Haryana), India*
[2]*Department of IT, JMIT, Radaur (Haryana), India*

ABSTRACT- Wireless and mobile communications are two of the fastest growing microelectronics applications, and have an enormous impact on our daily lives. Driven by the insatiable commercial demand for lower cost and higher bandwidth and functionality RF transceivers, wireless communication systems are moving towards higher integration, while operating at higher frequencies. A technology which can maintain a balance among all of these factors will become the dominant technology of choice for future wireless applications. Apart from communication systems, VCOs are integral part of biomedical applications. As the feature size getting smaller, CMOS technologies became attractive for the realization of high speed and high frequency ICs. The objective of the work is to design a low frequency VCO for pacemaker application. For this, numbers of CMOS VCOs are designed by using two techniques, and their comparative study is done on the basis of their linearity. The VCO showing the best linearity is chosen for pacemaker circuit.

KEYWORDS: Frequency Synthesizer, Biomedical, Pacemaker.

1. INTRODUCTION

Heart pacemakers have now been in use for nearly ten years and during this time have become a powerful therapeutic tool. Developments in semiconductor microelectronics have resulted in increasingly sophisticated pacing circuitry, beginning with the use of two transistors in the first implantable pacemaker in 1958. During the first years, a rather high incidence of pacemaker failures was experienced. Integrated circuits were first used in a pacemaker in 1971 and were quickly adopted as the standard for pacemaker design. Since then, reliability has been improved by selecting highly reliable components for the circuits and by carefully testing each device before implantation. The trend toward increasing levels of integration in design has continued. Whereas IC's in 1980 had device geometry on the order of several microns, IC's today may have device geometry on the order of 1um or less Hybridisation has pacemakers. Pacemakers have required more processing power and memory to carry out an increasing number of functions; more circuitry, often several IC's assembled into very large – scale (VLSI) applications and interconnections between those circuits were needed. The VLSI was at first only mounted on one side of substrate, later on both sides. Now chips are placed atop one another, involving very dense packaging; and double –sided hybrids are state-of- the- art. So nowadays, pacemakers are designed in CMOS. In today's era, CMOS IC'S with low power consumption and high reliability have replaced bipolar technology. Digital and analog functions can be designed on the same chip. The requirements of low power consumption must be met along with equally demanding goals of high chip density and high throughput. Low-power design of digital integrated circuits has emerged as a very active and rapidly developing field of CMOS design [1-3].

The heart's "natural" pacemaker is called the senatorial (SA) node or sinus node. It produces the electrical impulses that cause your heart to beat. Heart rhythm problems may occur when the natural pacemaker is defective, causing the heartbeat to be too fast, too slow or irregular. Main purpose of pacemaker is to keep the electrical system from too slow and thereby prevent the problems associated with slow heart rhythms (Passing out, congestive heart failure, and others include death). Pacemaker is used to electronically stimulate the heart to contract during periods when intrinsic cardiac electrical activity is inappropriately slow or absent and thus to pump blood throughout the body. Thus the term "Artificial pacemaker" is

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

used for a small battery-operated device that helps the heart beat in a regular rhythm and is implanted into the body specifically in the heart [4-7].

2. CLASSIFICATION OF CMOS VCOS

Oscillators are autonomous circuits that produce a stable periodically time varying waveforms. They have at least two states and they cycle through those states at a constant pace.

There are two methods which are used for design of CMOS Voltage controlled oscillators on silicon ICs.

- By Use of Ring Oscillators
- By use of Schmitt Trigger
- Ring Oscillators

Ring oscillators [1] consist of an odd number of single-ended inverters or an even/odd number of inverters with the appropriate connections and this is described in detail in the next chapter. It is primarily employed in some applications due to its wide tuning-range, high integration and small layout area. The oscillation frequency is directly related to the delay time of each inverter, resulting in high sensitivity to process and temperature variations. Its nonlinear voltage-to-frequency transfer characteristic gives high VCO gain at low frequencies.

Schmitt Trigger [2] is a circuit useful in generating clean pulses from a noisy input signal or in designing the oscillator circuits. Its transfer characteristics are similar to that of inverter with the exception of a steeper transition region. When the output is high and the input exceeds V_{SPH} (high switching point voltage), the output switches low. However, input voltage must go below V_{SPL} (low switching point voltage) before the output can switch high

3. VCO CIRCUIT TOPOLOGY DESCRIPTION

The central ring oscillator block consists of an odd number of series-connected inverters. The number of inverters is determined by the targeted operational frequencies and power requirements for the design [4]. The biasing block consists of an input-stage (transistors) where a voltage-to-current conversion is performed, and of N arrays of paired NMOS and PMOS transistors acting as matched current sources to ensure even drive. The input and paired transistors are connected in a current mirror configuration, where the input drain current (I_d) is mirrored through the current sources, resulting on a modulation of the drive current available to the inverter chain. Therefore, by affecting the sinking and sourcing properties of each inverter, a precisely controlled frequency of oscillation can be set.

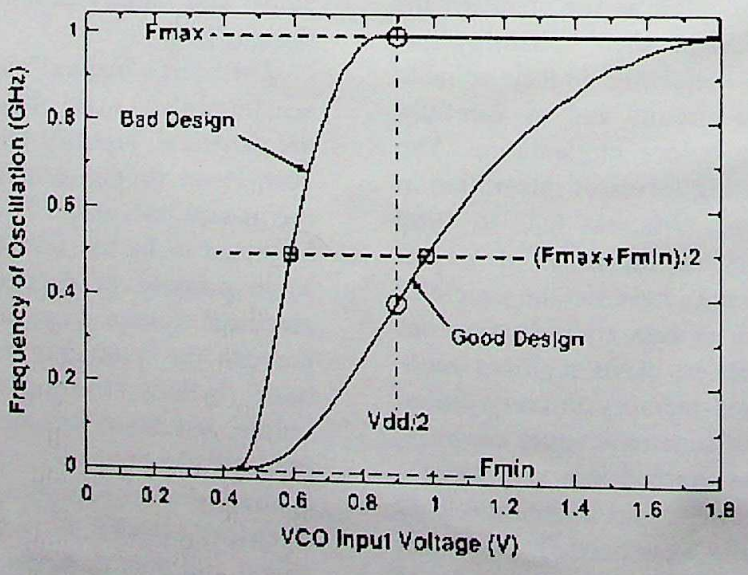


Fig.1: Control voltage *vs.* frequency curve.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Each VCO is designed such that it oscillates at a central frequency f_c (frequency of oscillation at $V_{in\ vco}=V_{dd}/2$) close to the center of the possible range of oscillation $(F_{min}+F_{max})/2$. This is to ensure a symmetric range of linear operation around f_c, therefore limiting VCO nonlinearities to the corners of the gain characteristic. Figure 5 illustrates the importance of such care in f_c design as we compare two examples of VCO designs using the topology as shown in figure 4, with transfer curves presenting similar oscillating ranges (same F_{min} and F_{max}) but that differ sharply in their gain profiles. The quality of a VCO design can be assessed by the relative proximity of two characteristic points -the intersection of the VCO transfer curve with the $V=V_{DD}/2$ and the $F=(F_{min}+F_{max})/2$ lines- as it indicates how close the VCO transfer function is to achieving the ideal slope of $(F_{max}-F_{min})/(V_{dd}-V_{thn})$

The top curve has its two characteristic points spread far apart-indication of a poor design- as the transfer function exhibits a high gain on a narrow linear range for voltage control and an early saturation, where the frequency is "stuck" at F_{max} and is no longer "controllable." The bottom curve has its two characteristic points close to each other and shows a wide linear range, where the VCO is very responsive with a near constant slope and where saturation is limited to corners only. This makes the fine tuning of the VCO to a desired oscillating frequency possible, as the voltage-to frequency conversion is made with much higher resolution.

The poor VCO design is due to a deliberately induced mismatch between the W/L ratios of M_{P1} and M_{Pbias} transistors, stressing the importance of properly understanding the design theory of this particular topology. Traditionally, relaxation oscillators using CMOS technology have been used for low frequency applications, but submicron processes have allowed CMOS oscillators to achieve frequencies in the gigahertz range. This range is made possible with the use of automatic swing control.

3.1. VCOS Using Ring Oscillator

There are different configurations of VCOs, designed using ring oscillator which are mentioned as below-

i. Current Starved VCO (I) [4]
ii. Current Starved VCO (II)
iii. VCO with gates of PMOS transistors grounded
iv. VCO with PMOS transistors diode connected
v. VCO with source voltage applied to both PMOS and NMOS transistors
vi. VCO with Linearizing Circuit [3].

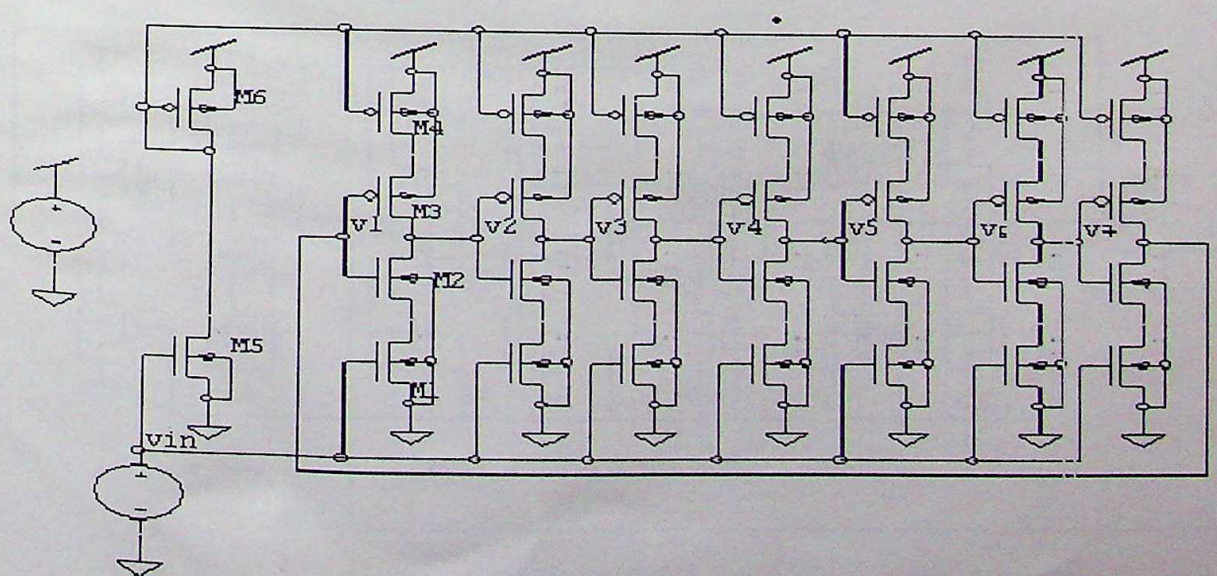


Fig. 2: Schematic circuit of Current Starved VCO (I).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

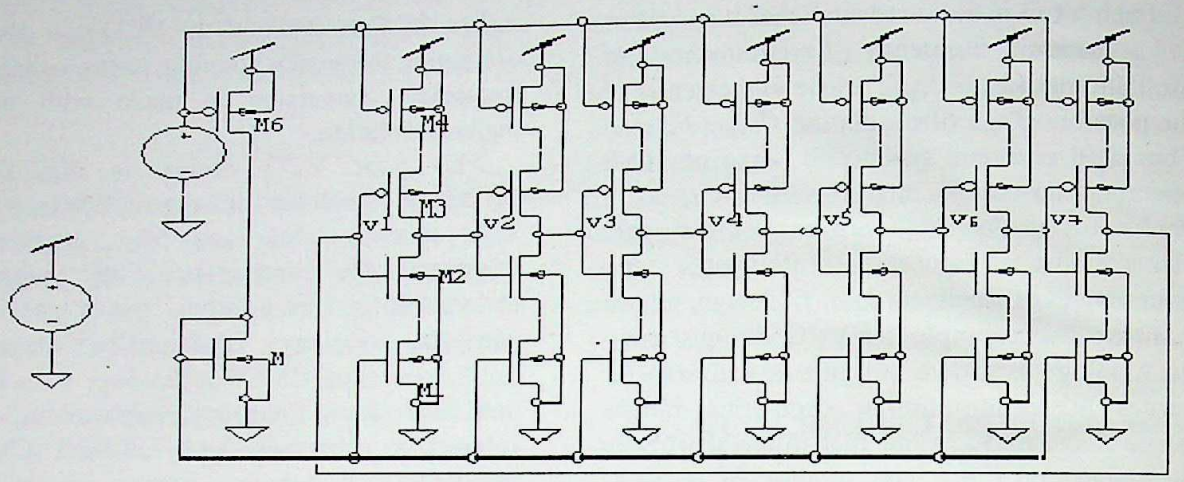


Fig. 3: Schematic circuit of Current Starved VCO (II).

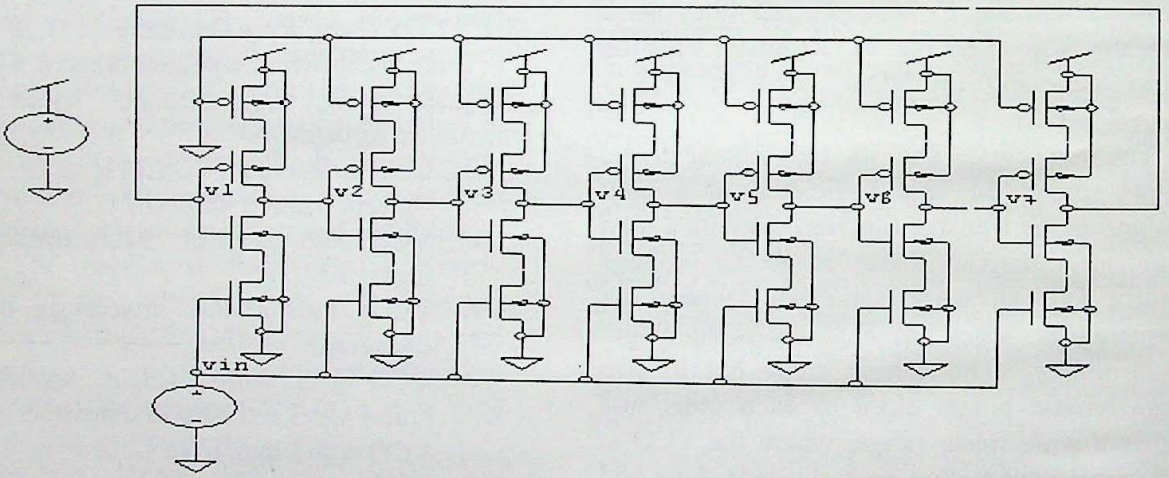


Fig. 4: Schematic circuit of VCO with gates of PMOS Transistors Grounded.

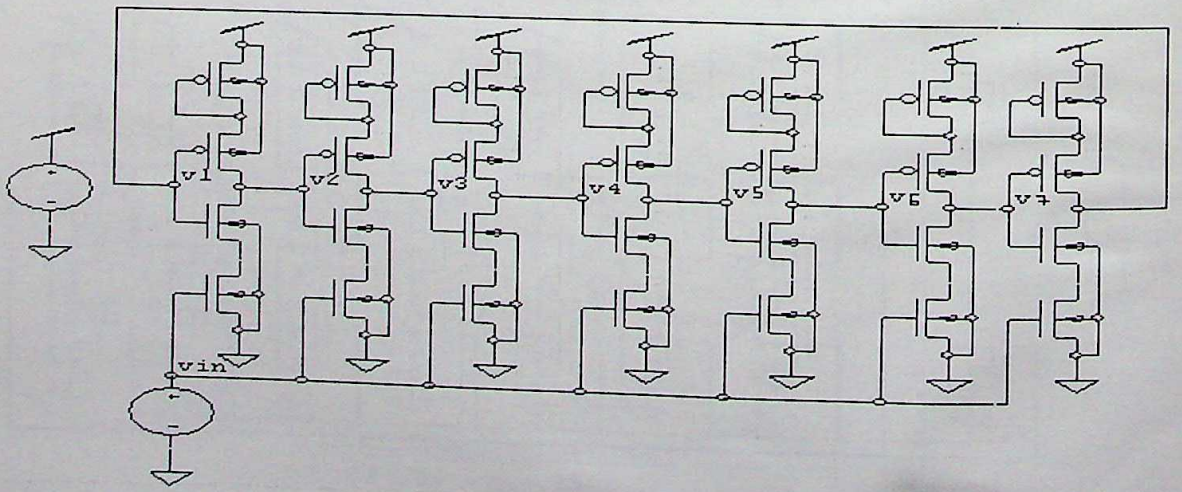


Fig. 5: Schematic circuit of VCO with PMOS transistor diode connected.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

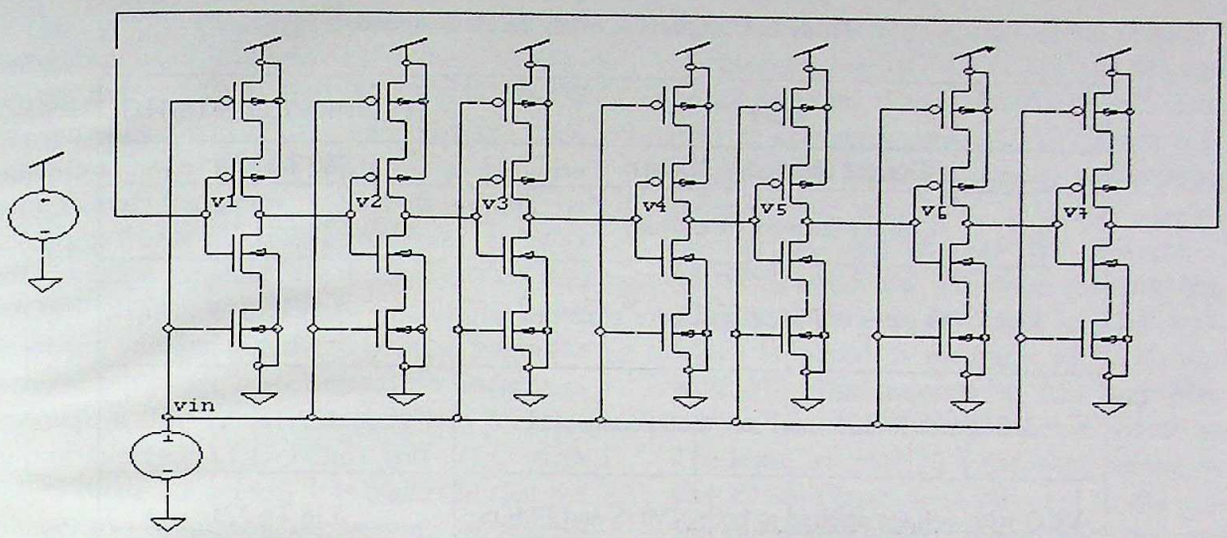


Fig. 6: Schematic Circuit of VCO with voltage applied to both PMOS & NMOS.

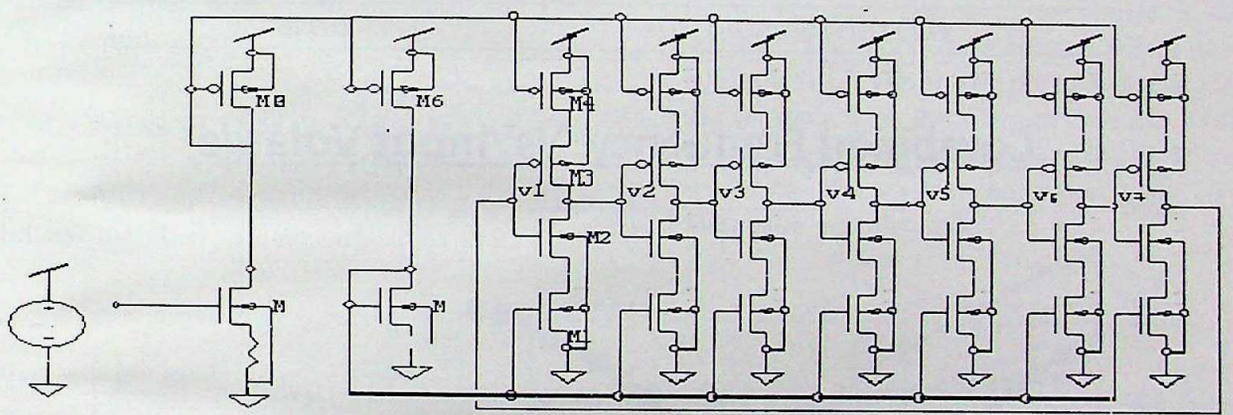


Fig. 7: Schematic Circuit of VCO with Linearizing Circuit.

All the circuit configurations used for VCO using Ring Oscillator mentioned above are shown in figures 2 to figure 7.

3.2 VCO Using Schmitt Trigger

VCO using Schmitt trigger is shown in figure 8.

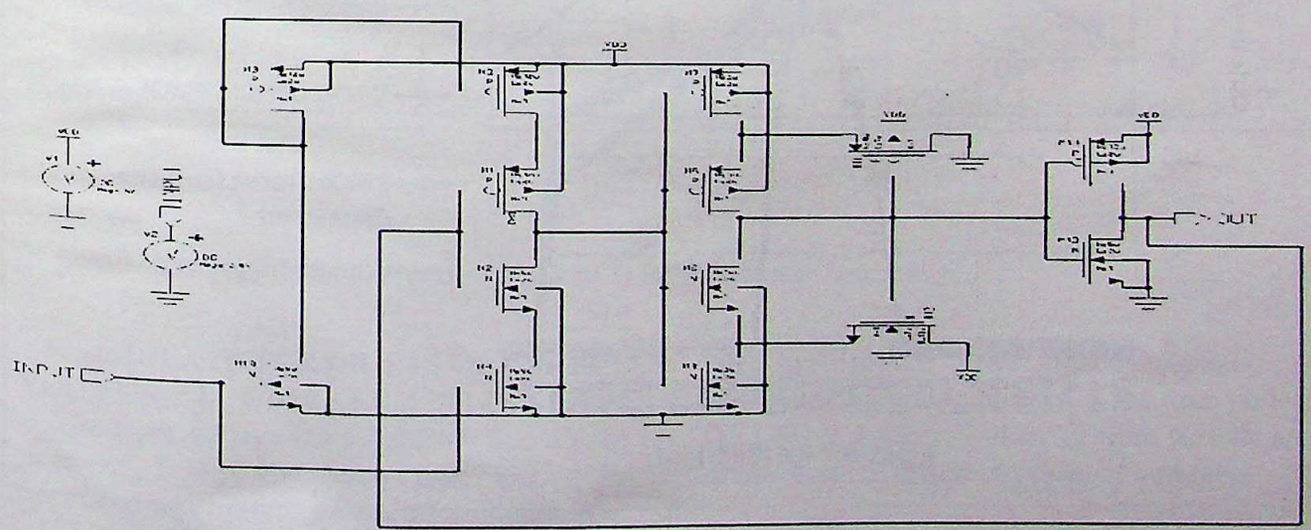


Fig. 8: VCO using Schmitt Trigger.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Table 1: Comparison of all VCOs designed

VCO	Frequency Range (MHz)
Current Starved VCO(Ist)	89 To 329
Current Starved VCO(IInd)	86 To 347
VCO with gates of PMOS transistor grounded	156 To 376
VCO with PMOS transistor diode connected	122 To202
VCO with voltage applied to both NMOS and PMOS	138 To 221
VCO With Linearized Circuit	229 to 316
VCO Using Schmitt Trigger	200 to 330

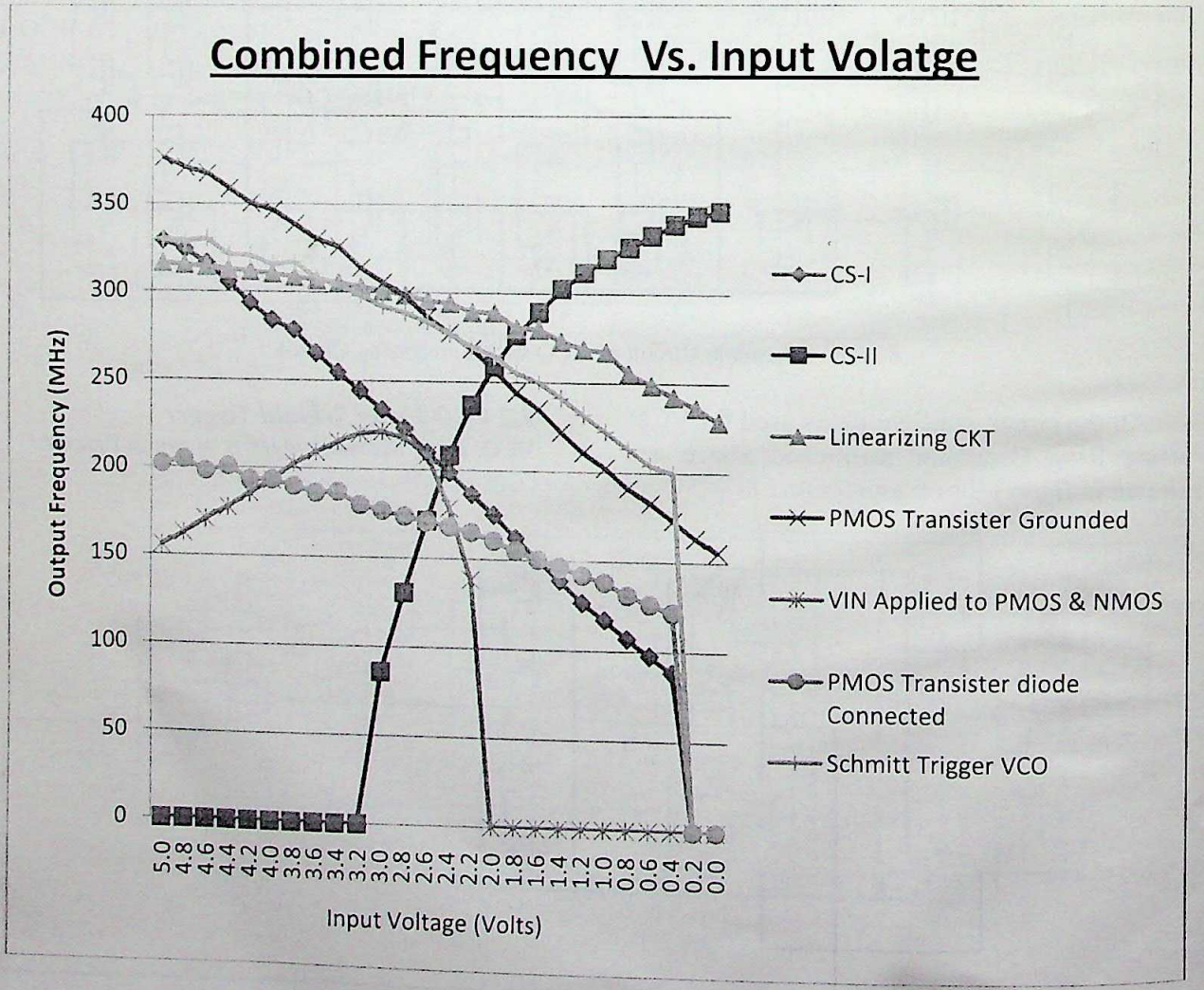


Fig. 9: The comparison of all VCOs

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The graph showing comparison of all configurations, it is observed that three VCOs - Current Starved VCO (Ist), VCO with PMOS gate grounded and VCO with PMOS diode connected have linear relationship between voltage and frequency means if voltage is increased, frequency is also increased. In VCO with voltage applied to both NMOS and PMOS, frequency is firstly increasing with increasing voltage, but after a point, it begins to decrease as voltage is increased. No linearity is observed in this VCO. In rest of two VCOs - Current Starved VCO (IInd) and VCO with NMOS diode connected, it is observed that the voltage and frequency are varying in inverse relationship.

The best linearity is observed in Current Starved VCO-I hence can be used for Pace Maker Application.

4. CMOS VCO FOR PACE MAKER APPLICATION

This VCO is designed using ring oscillator and its operation is also similar to that. From the schematic circuit shown in the Figure 10, it is observed that MOSFETs M2 and M3 operate as an inverter, while MOSFETs M1 and M4 operate as current sources. The current sources, M1 and M4, limit the current available to the inverter, M2 and M3; in other words, the inverter is starved for the current. The MOSFETs M5 and M6 drain currents are the same and are set by input control voltage, which is varied in the steps of 0.2V, starting with 5V. The currents in M5 and M6 are mirrored in each inverter/current source stage. There are in total 30 transistors, where upper PMOS transistors are connected to the gate of M6 and source voltage is applied to the gates of all lower NMOS transistors [5]. The normal rate at which heart beats is 72 beats/min. It is found that time period of one pulse is 60/72 seconds. Therefore, frequency of pulses needed is 72/60 = 1.2 Hz. In the present Investigation, the frequency of the Current Starved VCO is being lowered by doing some modifications in it i.e., by placing the capacitors in the circuit after each inverter stage

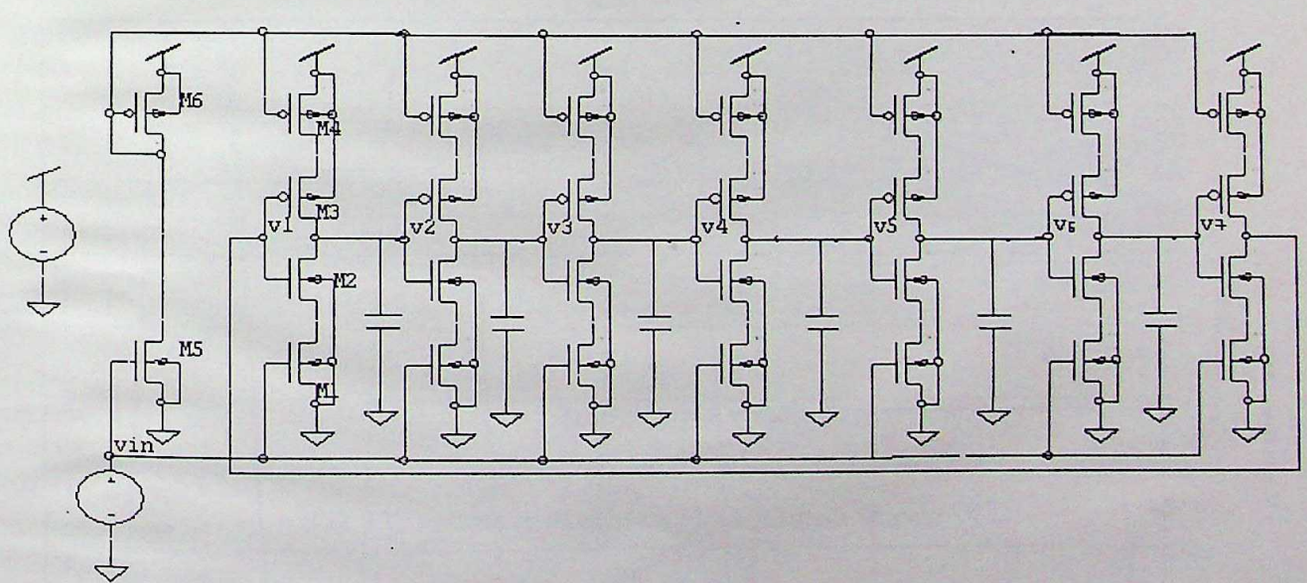


Fig. 10: CMOS VCO for Pace Maker Application

5. SIMULATION RESULTS OF CMOS VCO FOR PACE MAKER APPLICATION

The input voltage is varied from 0 to 5V, in steps of 0.5V, and then time period is calculated at different values of voltages from the waveform. After that frequency is calculated by taking inverse of the time period. The Table 1 shows values of time periods and frequencies at different values of voltages.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

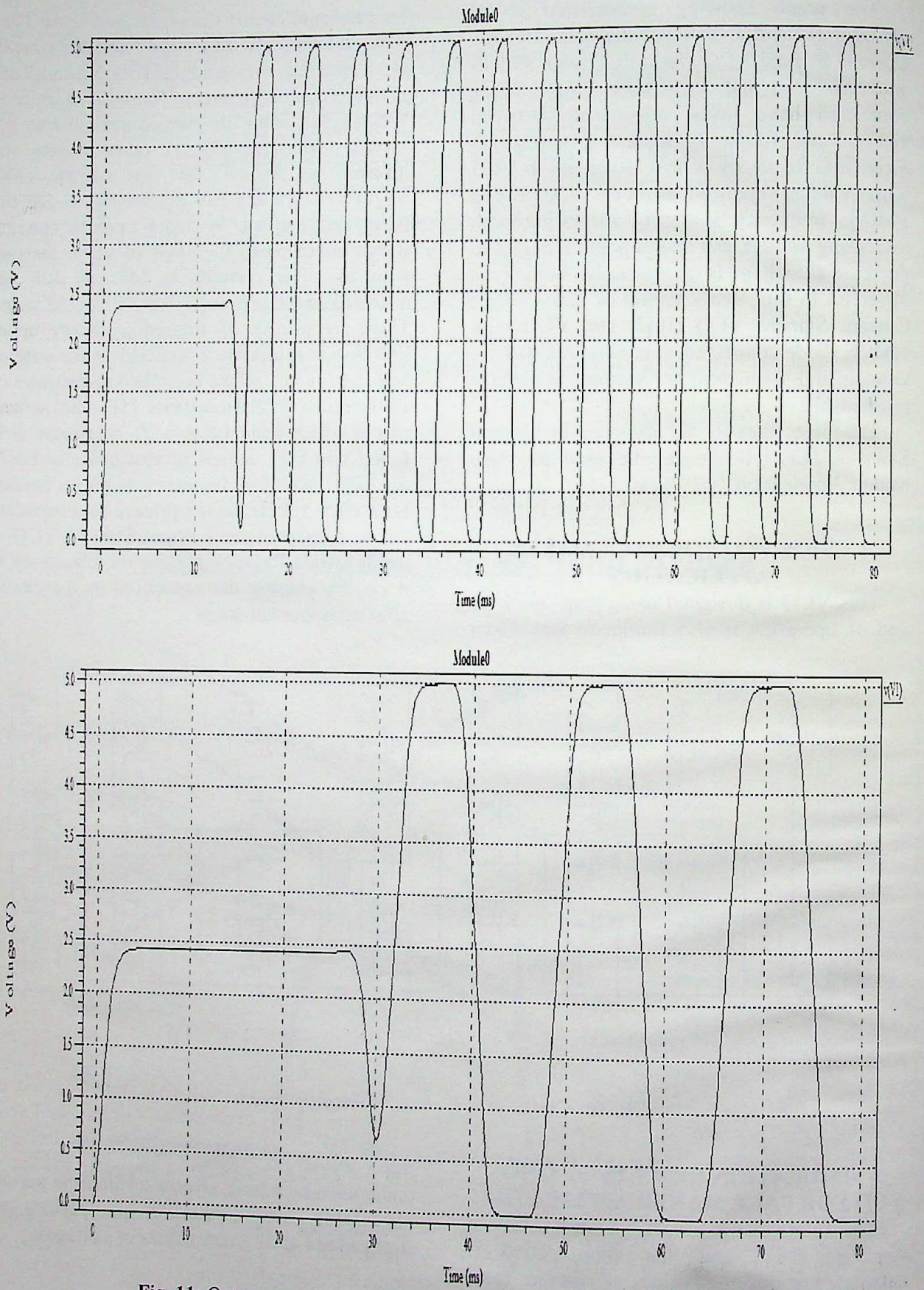


Fig. 11: Output waveforms of CMOS VCO for Pace Maker applications.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Table 2: Time periods and frequencies at different values of voltages

CMOS VCO For Pace Maker Application					
Sr. No.	VIN(V)	Time(s)	Frequency(Hz)	Peak to Peak	
1	5	0.2527	3.96	4.4351	86mv
2	4.5	0.2714	3.68	4.4177	94mv
3	4	0.29434	3.40	4.4046	105mv
4	3.5	0.3216	3.11	4.384	117mv
5	3	0.3655	2.74	4.3659	130mv
6	2.5	0.4097	2.44	4.347	145mv
7	2	0.48339	2.07	4.3254	162mv
8	1.5	0.61106	1.64	4.3012	182mv
9	1	0.81291	1.23	4.27	206mv

In order to observe the relation between these two quantities a graph is plotted between voltage and frequency as shown in figure 12.

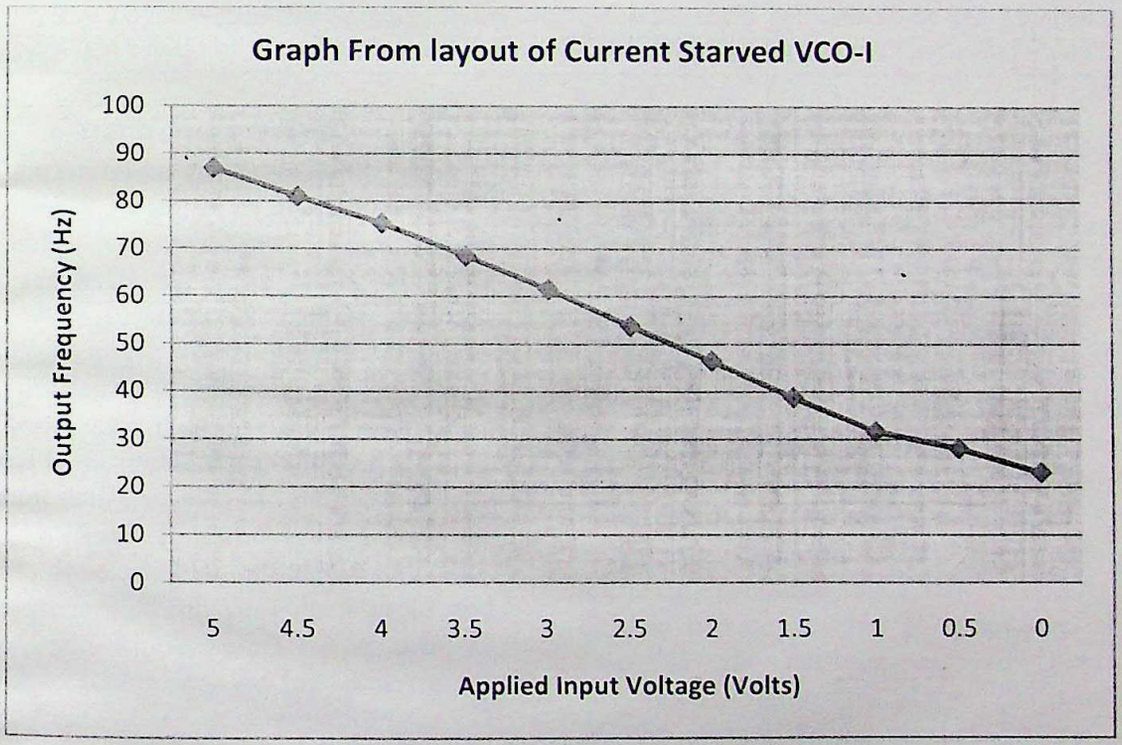


Fig. 12: Voltage *vs.* Frequency Plot of Current Starved VCO.

7. CONCLUSION

This paper present use of ring oscillator based current starved VCO for Pace Maker Application. This VCO is having good linearity (frequency over a wide voltage range).The power consumption is also found to be minimum compared to other VCO. The circuit was simulated by using Tanner EDA tools to get the above shown results. As observed from the above graph, it is found that as voltage is increased, frequency is also increased and the range in which linearity is observed is 3.96 to 1.23 Hz. From the simulation results, it is observed that the minimum frequency achieved is 1.23 Hz at a control voltage of 1.0 V. The actual frequency required for pacemaker circuit is 1.2Hz, so this circuit can be utilized for pacemaker application.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REFERENCES

[1] http://www.fairview.org

[2] Adel S. Sedra and Kenneth C. Smith, Microelectronics Circuits, 5th edition, Oxford University Press, 2004.

[3] R. Jacob Baker, Harry W. Li and David E. Boyce, CMOS Circuit Design, Layout and Simulation, *IEEE Press Series on Microelectronics Systems* 355-361 and 383-387 (2000).

[4] Y. Boulghassoul, L. W. Massengill, A. L. Sternberg, and B. L. Bhuva, Y. Boulghassoul, L. W. Massengill, A. L. Sternberg, and B. L. Bhuva,. Effects of Technology Scaling on the SET Sensitivity of RF CMOS Voltage-Controlled Oscillators, *IEEE transaction on nuclear science*.52 (6), 2005.

[5] B. Razavi, Design of Analog CMOS Integrated Circuits, *Tata McGraw Hill*, 484-574 (2002)

[6] W.R. Liou, T.H. Chen, M.L. Yeh and J.J. Ho, A low-noise low-power 4.6-GHz CMOS VCO with coupling effect reduced inductors, Graduate Institute of Electrical Engineering, National Taipei University, Taiwan, ROC, 2005.

[7] H. Darabi and A. Abidi, A 4.5mW 900-MHz CMOS Receiver for Wireless Paging, *IEEE Journal of Solid-State Circuits* 35, 1085-1096 (2000).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS
J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.63-67 (2011)

GRIDOC: Online Grid Service for Biomedical Assistance

Tarang Arora, Devendra Kumar and Amit Agarwal
Department of Computer Science & Engineering, College of Engineering Roorkee, India

ABSTRACT- Gridoc is the amalgamation of Grid computing and Internet Doctor. The Grid is a type of parallel and distributed system that enables the sharing, selection and aggregation of geographically distributed autonomous resources dynamically at runtime depending on their availability, capability, performance, cost, and users' quality of service requirements. It is a large scale autonomous resource pool used to solve problems in parallel to find fast solution. Gridoc is an approach towards bio-medical support services aggregating grid technologies and Internet Doctor. This system has been developed in order to aid paramedical services it would provide, e.g., death rate caused by insufficient or improper first aid would be decreased by a significant factor. Gridoc would enrich an ordinary person with the required knowledge of bio-medics that would be useful at the time when he needs. Urgent assistance is one crucial issue handled by this technology. Besides it, normal medical assistance is another important feature. People would not have to wait for their appointments with the doctors and an ordinary person would not have to suffer in absence of a medical officer for less severe cases. Gridoc can be used for assistance with just a simple effort of querying the system. The query system provides the user with a response within few seconds. Every single person would get support by the paramedics and would be able to get benefit by curing less severe medical problems by interacting with the Gridoc System.

1. INTRODUCTION

The Computational grids enable the sharing, selection, and aggregation of a wide variety of geographically distributed computational resources (such as supercomputers, compute clusters, storage systems, data sources, instruments, people) [1, 2] and presents them as a single, unified resource for solving large-scale compute and data intensive computing applications (e.g., molecular modelling for drug design, brain activity analysis, and high energy physics) [1]. Such type of system may be helpful in development of a Global Bio-medical system that can provide a rapid and precise answer to its users. The primary objective is to find a way for fast accessibility to the database where grid network plays a crucial role. Grid network can traverse the whole database and can find the result in few seconds. It is a type of parallel processing with a large number of computing systems utilizing their computing cycles to process its own database. Grid computing is one of the advanced technology using the computing cycles, data and resources of authorized computers. Our objective is to provide a quick response to the client of his/ her query in form of a single and précised solution rather than providing website links as other search engines do.

2. REVIEW OF LITERATURE

As a number of biomedical literatures are growing rapidly, Information retrieval techniques with fast and accurate data have a vital role in what and how instantly we want the result. An informational retrieval system, as represented by PUBMED [2,3], retrieves the documents and Question Answering System [2] providing a direct answer is not only the requirement, but a hasty and instant system containing updated data with maximum accuracy is today necessity. Recently, the Gridoc service is able to overcome all the essential requirements of all previously developed systems. One of the significant traits of our system is the virtual integration of distributed database and the instant service offered by grid computing cannot be disregarded. This project is based upon the development of a globally distributed network of bio-medical answering system. Automation of grid network can provide one of the best solutions for it. Doctors can store and retrieve their data from grid databases anywhere at anytime. Only authorized doctors would be allowed to add and further update the shared bio-medical database.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

3. PROPOSED MODEL AND METHODOLOGY

The whole architecture of Gridoc is divided into two parts- (i) INDOC system (Bio-Medical Question Answering System) [2], and (ii) Grid system. As a whole, Gridoc system consists of four subparts.

3.1 User Input

The user inputs the query (or keywords) in text form in the search bar or in text message form. The user can decide in which language he wants to inscribe query but the system can understand only one language. It is far better to develop a translator (which translates all languages to one language) rather than different search engines for different language input. A large number of translators are available online. Google translator has become one of the best language translators which provide high accuracy at no cost.

3.2 Keyword Division

These keywords (extracted from user query) are further divided into parts if not recognised by NLP (natural language processing) [4]. MMTX server is used to extract the information about the query. MMTX [3, 5] is an effort to make the MetaMap program available to biomedical researchers in a generic, configurable environment. MetaMap maps arbitrary text to concepts in the UMLS [6,7] Metathesaurus, or, equivalently, it discovers Metathesaurus concepts.

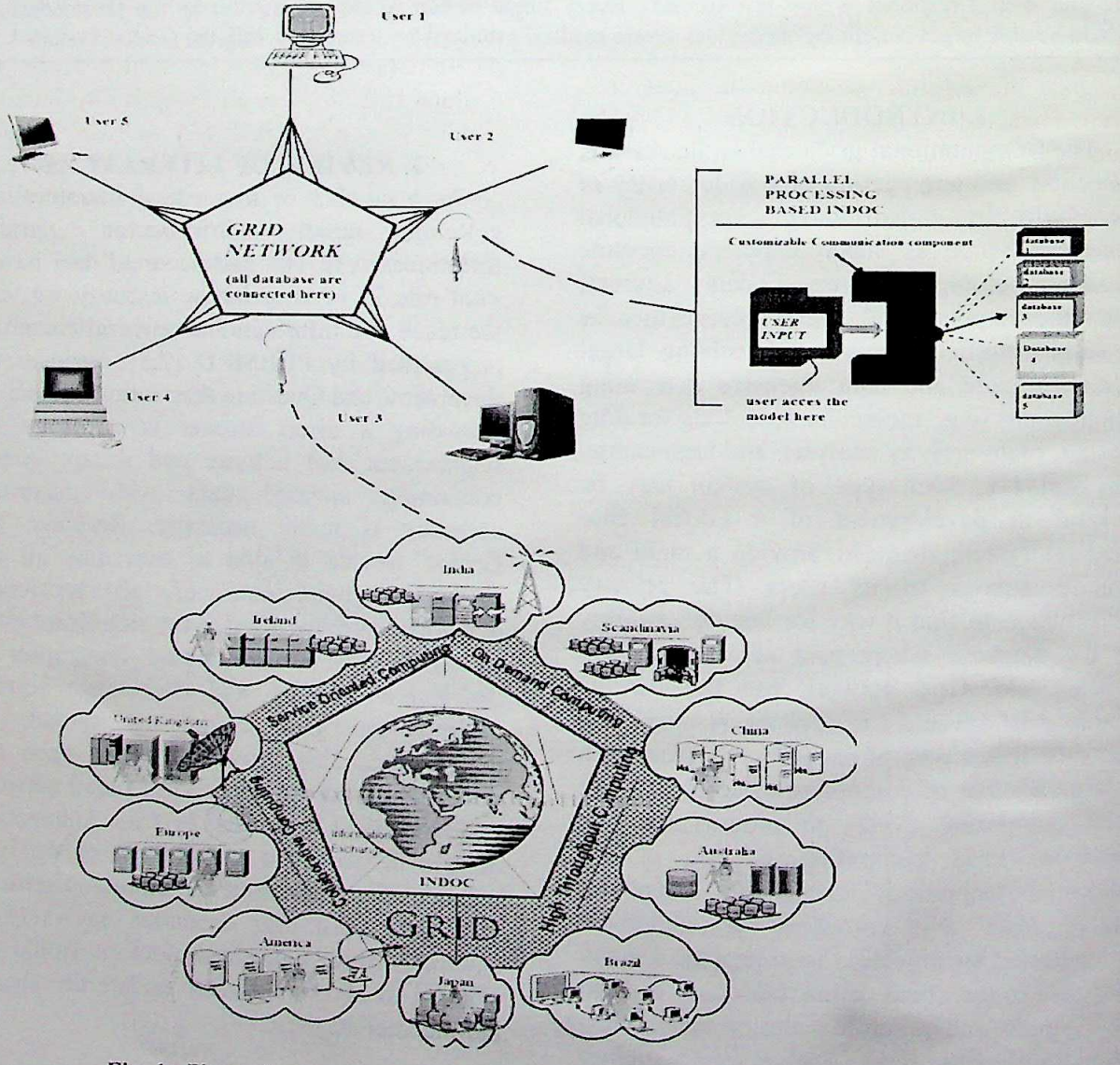


Fig. 1: Flow of user query from local processors to global distributed grid database.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

With this software, text is processed through a series of modules. First it is parsed into components including sentences, paragraphs, phrases, lexical elements and tokens. Variants are generated from the resulting phrases. Candidate concepts [3], from the UMLS Metathesaurus are retrieved and evaluated against the phrases. The best of the candidates are organized into a final mapping in such a way as to best cover the text. By using MMTX, it becomes quite effortless to find what actually user wants to search. The keywords are given weight according to their priority. This phase works on the principle of Divide and Rule. After taking input, the Gridoc proceeds further to next phase, i.e., Parallelisation.

3.3 Local Database Searching using Parallel Processors

Once the information about the query has been extracted, whole system works on the same job, i.e., search the maximum documents from the database. The database is locally as well as geographically distributed. The local database is accessed using parallel processors. A number of processors process the query and search different databases. If the relevant or enough information is not found in the local database then global database is searched using GRID.

3.4 Global Database Search using Grid Network

To find the fast accessibility to distributed database is the main point to concern if system is unsuccessful to get a satisfactory answer from its local database. That's where Grid Network shows its importance. The Grid network can explore whole database within some seconds and can find the result. It is a kind of parallel processing with a large number of systems using their computing cycles to search their own database.

4. ANALYSIS

The functioning of internet Doctor is same as was before but there is a amendment in the vastness of data pool and process of retrieval of data. The technique has been changed and the database has been upgraded to global standard. Cellular text message querying is also included making it more flexible, fast and user friendly. Worldwide distributed network of powerful computers systems result in exploration of data within few seconds. Internet doctor is upgraded to Gridoc featured with higher efficiency and standard. The information pool consists of data clustered not just from a single region on the map and it is obtained by the combinational support of doctors across the globe.

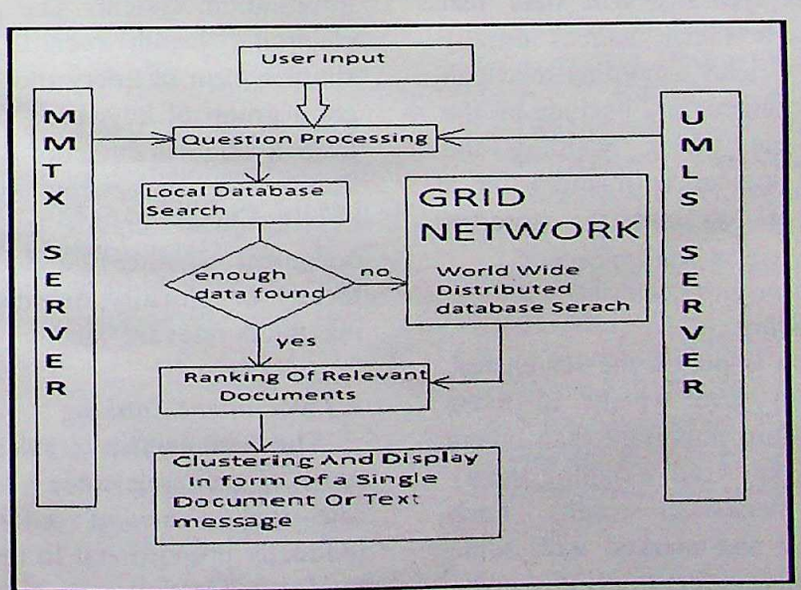


Fig. 2: Working of the GRIDOC-System

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Once the information in response to the query has been extracted, whole system would work on the same job, i.e. searching the maximum information from the database. The database is locally as well as globally distributed. The local database is accessed using parallel processors. A number of processors process the query and search different databases. The Geographically distributed database will be searched through Grid Network. The distributed processors would search their own database and provide the accurate and instant solutions relevant to the user query.

A large number of geographically distributed computer systems are given authorisation. They are given their own network keys. A Grid Network is formed amongst them and a search engine is established. As a query is asked, the whole procedure works into some phases as follows:

4.1 Indexing

A database index [2] is a data structure that improves the speed of data retrieval operations on a database table at the cost of slower writes and increased storage space. Indexes can be created using one or more columns of a database table, providing the basis for both rapid random lookups and efficient access of ordered records. The disk space required to store the index is typically less than that required by the table (since indices usually contain only the key-fields according to which the table is to be arranged, and exclude all the other details in the table), yielding the possibility to store indices in memory for a table whose data is too large to store in memory.

4.2 Question Processing

Once the question is put on the search bar, the first task is to give weight to those keywords that are more important than others [3]. In this process, keyword weighing theory also gives more beneficial results. Each Keyword is checked and marked with some weight. The weight here refers to priority given to each keyword, i.e., higher priority, large amount of data is retrieved. For example: in the query "tell me the symptoms of malaria", words "symptoms and malaria" are given more weight than "tell me".

The second methodology is NLP [4] based, i.e., Natural Language Processing. The Techniques of natural language processing have been under development since the earliest computing machines, and in recent years these techniques have proven to be robust, reliable and efficient enough to lead to commercial products in many areas. The applications include machine translation, natural language interfaces and the stylistic analysis of texts but NLP techniques have also been applied to other computing tasks besides these. Finally, the prospects for gains in terms of overall retrieval effectiveness or quality will be discussed. For example, if a query "heart attack cure" is put on the search engine, then the user would like to come across a document containing information only about the "attack cure" rather than its preventions, medical treatment, surgery or only about heart. Thus there is a need to get correct result by a cluster search not by searching keyword search.

The Unified Medical Language System (UMLS) dictionary is required to get simpler form of typical bio-medical words. The UMLS integrates and distributes key terminology, classification and coding standards, and associated resources to promote creation of more effective and interoperable biomedical information systems and services, including electronic health records. Once we get a simpler form of query then we can proceed to get a group of keywords that can be matched from a huge documents distributed database. The whole processing system acts like a Crawler who crawls each word in each document whether the document database is locally or globally distributed and finds the maximum relevant data.

4.3 Document Ranking

The documents are ranked in the decreasing order of their relevance with the input query. The rank value of a given document is indirectly proportional to the related keywords found after sorting.

$R_i = k/(W.K_i)$,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

पुस्तकालय
132082
गुरुकुल कांगड़ी विश्वविद्यालय

Where, R=Rank of document; i document number, k = Constant, K_i = relevant keywords found, W= weight of the keywords found.

4.4 Clustering

Document clustering (also referred to as Text clustering) [1,7] is closely related to the concept of data clustering. Document clustering is a more specific technique for unsupervised document organization, automatic topic extraction and fast information retrieval or filtering. A web search engine often returns thousands of pages in response to a broad query, making it difficult for users to browse or to identify relevant information. But Gridoc clustering [1,7] provides a single clustered document containing a brief answer with most relevant results. The lowest rank value document is placed above all and then the second lowest ranked document after that and so on. The data collected after document ranking is merged. And an accurate answering document is formed.

Final Document = D1 (rank=1) +D2 (rank=2)....DN (rank =3)

4.5 Answering

The main purpose is to provide a quick and most relevant answer to the client for its question. The search results are given to the user in a fraction of seconds in the new merged document form. A document containing a brief solution is required.

4.6 User Certification

User validation is necessary. Only those users would be able to update database of Gridoc who will be authorised. They include Doctors, Database Administrators etc. If a doctor need some help from another one, then they can connect to each other and even they can access their updates.

5. CONCLUSION

Gridoc provides a feasible and trustworthy source of answering user querying. It provides:

- Online Doctor
- SMS Approach
- Fast Accessibility
- Easy Approach
- Updated Database

It is not an innovation but a revolution to human cause. This system may become a cause for a high decrement in death rate in near future. It would act like a First Aid [5] to its victim and as a first help to doctors and patients.

REFERENCES

[1] I. Foster, C. Kesselman,, J. Nick and S. Tuecke, The Physiology of the Grid: An Open Grid Services Architecture for Distributed Systems Integration, *Argonne National Laboratory*, 2002.

[2] C. Sable, and M. Lee, Question Analysis for Biomedical Question Answering, *Proc. of Annual Symp*, 2005.

[3] P. Sondhi, R. Purushottam,, V. Kumar and Ankush Mittal, Question Processing and Clustering in INDOC: A Biomedical Question Answering System, *EURASIP Journal on Bioinformatics and Systems Biology*, 2007

[4] Schultz, S., Honeck, M., and Hahn, H., Biomedical text retrieval in languages with complex morphology, *Proceedings of the Workshop on Natural Language Processing in the Biomedical domain, Philadelphia, Pa, USA*, 61–68 (2002).

[5] Y. Niu and G. Hirst, Analysis of Semantic Classes in Medical Text for Question Answering, Ontario Canada, 2003.

[6] A. Koike, and T. Takagi, Gene/protein/family name recognition in biomedical literature, *Proceedings of HLT/NAACL BioLINK workshop*, 9-16 (2004).

[7] A. R. Aronson, Effective mapping of biomedical text to the UMLS Metathesaurus: the MetaMap program, *Proc AMIA Symp*, 17-21 (2001).

[8] D. Abramson, R. Sosic, J. Giddy, and B. Hall, Nimrod: A Tool for Performing Parametised Simulations using Distributed Workstations, *4th IEEE Symposium on High Performance Distributed Computing, Virginia, USA*, 1995.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri
Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS
J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.69-75 (2011)

Mobile Agent Model for IT in Education System

Savita Nawani[1], Mayank Aggarwal[2#] and Amit Agarwal[3]
[1]*Manav Bharti University, Solan, India.*
[2]*Faculty of Engineering & Technology, Gurukula Kangri Vishwavidyalaya, Haridwar, India*
[3]*College of Engineering, Roorkee, India.*
[#]Corresponding author (Email:uormayank@yahoo.com)

ABSTRACT- According to new evaluation system, students will be evaluated throughout the sessions rather than evaluating only two times in a year. This type of evaluation process consists of number of variations which are periodic. Modern Evaluation System helps in improving student performance by identifying his/ her learning difficulties at regular time intervals right from the beginning of the academic session and employing suitable remedial measures for enhancing their learning performance. Mobile agents are defined as objects that have behavior, state and location [5]. We have introduced a model that uses mobile agents to help the administration, teachers, and students to make the teaching, learning and continuous evaluation efficient & effective. Recently mobile agents have been increasingly adopted in education. They have become important as a means of reducing the amount of time teachers must spend on instructional tasks that require high levels of repetition. These agents provide feedback on student work; promise to allow teachers to spend more time to help the students while facilitating additional interactions that fit within the demanding classroom schedule as well as modern continuous evaluation. MathNet proposes a new Computer Supported Learning Environment that explores the Cooperative Learning paradigm.

KEYWORDS: Mobile agents, Continuous evaluation, Comprehensive evaluation, Scholastic areas, Co-scholastic areas.

1. INTRODUCTION

Mobile agents [1] can act as teaching assistants for digital learning courses by monitoring and managing course activities. Apart from traditional print based course materials and textbooks, the staff and the students use the web to deliver assignment files, supplementary study materials, and other correspondence with students. An electronic assignment handling system monitors student assignments. Assignments are considered an important element in the learning process. The assignment handling system enables students to submit assignments electronically, apply for some extra time, to know about the status of their submitted assignments, and receive timely feedback on assignments from the teachers. We investigated the deployment of mobile agents to act as the administrator agents, teaching agents, scholastic agents, co-scholastic agents, evaluation agents, result publishing agents, defaulter agents. The proposed design will meet the need of both students and teachers within the time constraints of the classroom. The SP (Service Provider) generates mobile agents that are essentially network conscious programs. These agents autonomously navigate through the network, from node to node [2]. The Push MAs carry the educational/learning contents of the system (on a server) located at SP to the adjacent network nodes. Contrary to the traditional method of making the information accessible to the users, the SP radiates the important contents of information to its nearest nodes [3].

2. PROBLEM

In modern evaluation system, student marks will be replaced by grades which will be evaluated through a series of curricular and extra-curricular evaluations along with academics. The aim is to reduce the workload on students and to improve the overall skill and ability of the student by means of evaluation of other activities. Grades are awarded to students based on work experience skills, innovation, steadiness, teamwork, public speaking, behavior, etc. to evaluate and present an overall measure of the student's ability. This helps the students who are not good in academics to

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

show their talent in other fields such as arts, humanities, sports, music, athletics, etc. It is to assess all round development of a child, irrespective of individual differences. And even if a child is not good in studies chances are given to the students again and again. So the process keeps on continuing through-out the session. In this situation the teachers valuable time is spend in record keeping only. So something is required to help the overall life cycle of teaching learning and evaluation which will work automatically, and can go for decision making (up to a particular level).

3. SOLUTION

It becomes nearly impossible for users to manually command/ control the complex software systems. Here need of sophisticated and automatic intelligence is required into the life cycle and development environment [4]. Here the agents may help a lot as they are programmed systems that can handle tasks autonomously with intelligence under some prescribed rules [4]. The difference between an agent and a traditional software entity is that the latter just follows its designed functions, procedures or macros to run deterministic codes. The former incorporates the ability to practice intelligence by making (autonomous/ semiautonomous) decisions based on dynamic runtime situations [1]. The need for autonomous control systems, reducing cost of running such systems and dynamic nature of complex systems are driving the adaptation of Agent-oriented considerations into software designs. Agents can be delegated to perform simple tasks or to provide autonomous services to assist a user without being "commanded." Agents play roles in terms of different expertise and functionalities while supporting services to an application. They are responsible for making intelligent decisions to execute such activities and to provide valid and useful results. Agents can work alone, but most importantly, they can cooperate with other agents. Agents are software components in the system that are viewed as many individuals living in a society working together.

4. MOBILE AGENTS AND THEIR PROPERTIES

Software agents can be defined in a number of ways depending on the functions and context. A general and widely accepted definition is that software agents are computational autonomous entities capable of sensing (such as acquiring information) and acting (such as producing and sending information) in an environment (such as a Web server) to accomplish a set of designated goals. A software agent is an intelligent program that acts as a user's personal assistant. Software agents endowed with the property of mobility are called mobile agents. Mobile agents perform a user's task by migrating and executing on several hosts connected to the network. In high-level view, basically mobile agent interacts with client side inference engine to pick up the data [5]. Then mobile agent moves to host (or server) side. At host side, mobile agent performs all the processes needed, such as updating the database, and interacting with database if required [5]. After mobile agent finishes all the tasks at the host side, it gathers all information it needs, and returns to the client side [5]. Then it updates the client side [5]. In addition, mobile agent approach can work in intermittent connectivity between client and host because mobile agent can be dispatched and it can work autonomously even if the sender is not available any more [5]. Mobile agents have following properties:

Intelligence, Autonomy, Responsiveness, Communicative Ability, Adaptability, Reduction of network traffic, Asynchronous autonomous interaction, Local processing of data.

5. MODEL FOR CONTINUOUS EVALUATION USING MOBILE AGENTS

Agents can be used to generate queries, stored procedures, triggers and user defined function and that also according to the user's requirements. Users can configure their agents to perform specific task or services. A mobile agent is a program that can autonomously migrate between various nodes of a network and perform computations on behalf of a user. Some of the benefits provided by

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

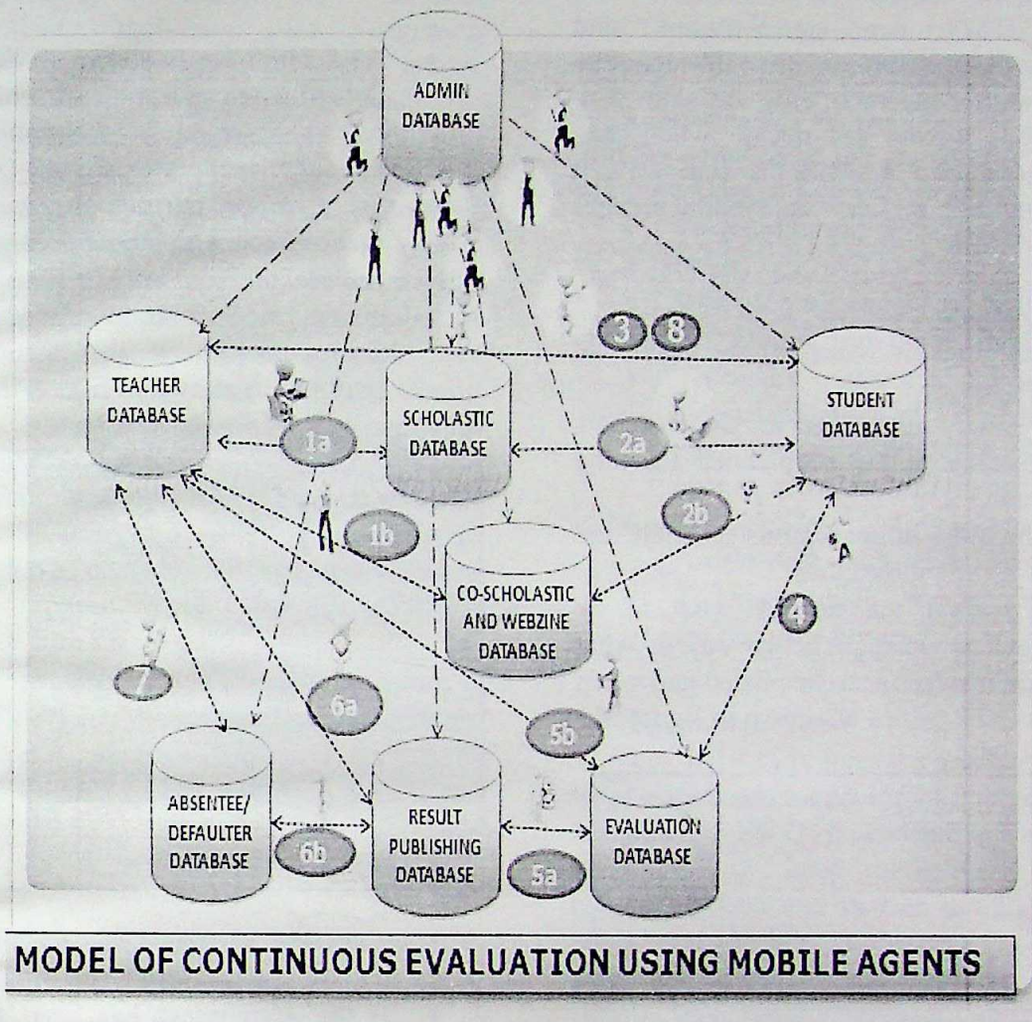


Fig. 1: Model of Continuous Evaluation

MAs for creating distributed applications include reduction in network load, overcoming network latency, fasterinteraction and disconnected operations [6]. An agent may have access to static and dynamic databases of Administration, Teacher, Student, Evaluation, Result, Scholastic, Co-Scholastic, Result Publishing Agents, and Defaulter. And they manage repeated tasks very efficiently. Based on this information and configuration settings provided by the owner of an agent, the agent can think & perform intelligence actions. The school portal will be having lot of data about students teaching, learning, evaluation progresses and their behavior. The information can be useful in providing useful timely and meaningful feedback on student progress and aids in early detection of problems to transform the teaching & learning process accordingly. But to the information for a single student the teacher has to go for various pages available on the school portal and then to get a conclusion and they have to initiate all the information retrieval tasks and to interact with them. So to manage the course & acquire useful information, the user must, directly interact with the school portal, initiate all tasks & monitor and process all the responses as shown in figure 1 of our model. This is a very time consuming process to retrieve and filter the information from various places. And it will be more difficult and tedious when a teacher has to do it regularly to verify student progress and participation. This includes regular checking of students' online activities, visiting the assignment submission of records to see if students have submitted their assignments, and reviewing the assignment marking records to

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

identify gifted students and students with problems. They are asynchronous and autonomous objects that can move throughout a network, transporting their code and data with it [7]. Mobile agents can decide where and when to move in a network. In that way, it obtains advantage to the locality and reduces the network traffic.

5.1 Teacher Agent

The mobile agents will help the teacher in the following ways:

- To send reminders to the teachers according to the preplanned teaching schedules.
- Upload the future lessons schedule and change in the syllabus.
- To remind the teacher what to be taught on what particular day & what study material is to be posted and when it is to be posted as shown in figure 2.

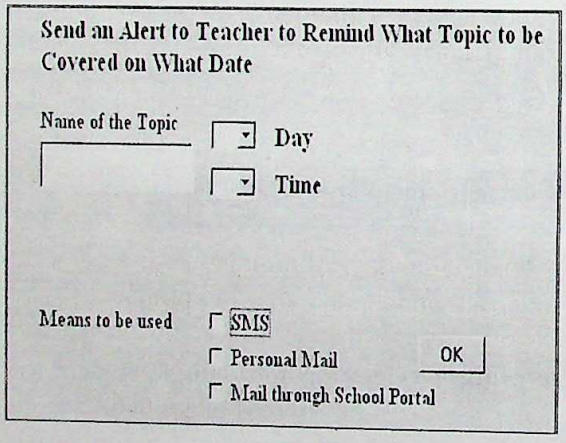


Fig. 2: Teacher Agent for Topic

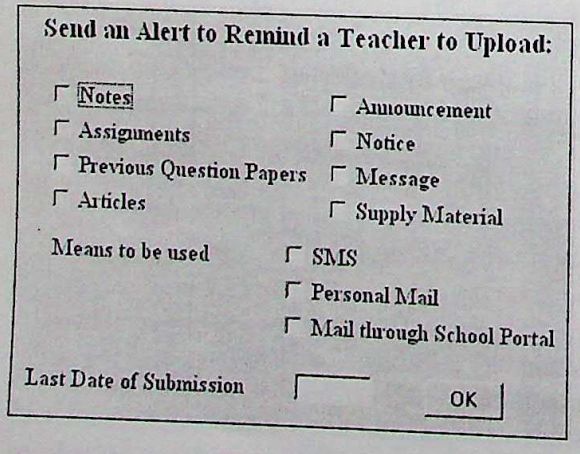


Fig. 3: Teacher Agent for Upload

- As a reminder is shown in figure 3 to upload notes, assignments, old question papers, articles, announcements, message, supply extra study material.
- To organize on-line quizzes, face to face session with students or parents.
- In case the student is not singing into portal account then to remind the student to check the account as a reminder is shown in figure 4.

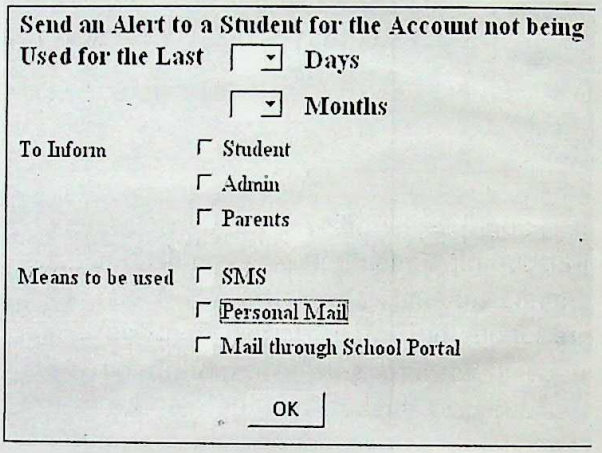


Fig. 4: Student Agent

- If the assignment has been submitted then in case Figure 5 of improper or incomplete assignment to guide the student and ask him/her for resubmission. Identify the students who have not attempted the exam, and to give them another chance as a reminder is shown in figure 5.

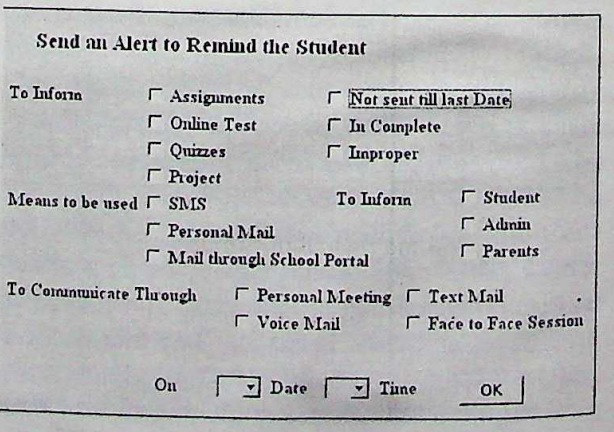


Fig. 5 : Student Agent for Reminder

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

- To notify the teacher about defaulter students, including past assignment submission record, previous grades, rank in the class, earlier work on projects. Then the teacher can take the appropriate action

So, they help the teacher to send different kind of material to students and what kind of language to be used soft /harsh in various notices. As it will be soft in first notice to remind student to submit the assignment. Then in second or third notices it will be strong. Generally a teacher comes to know about the progress of the student only when he/she look at work submitted by them. They cannot keep an eye on the steps of completion like when the students have downloaded the assignments/ notes/ exam paper. While using teacher agents they could:

- Constantly & dynamically be aware of a student's participation in a course.
- Identity the poor students.
- Help them before they drop out.

Suppose a student has not done well in a project then:

- He/she will be shown various exercises and to tell their importance.
- He/she will be shown the address of various sites which can help them much more.

a. A room on portal will be suggested where all the students working on that kind of project are working.

5.2 Student Agent

The mobile agents will help the students in following ways:

- To submit their work.
- To ask for extension for submission of their work.
- To go for team work in projects making a room on net.
- To inquire about the submitted assignment and receive the timely feedback from teachers.
- To help the students providing intelligent search engine working according to level of student and teacher requirement.

5.3 Administrator Agents

The mobile agents will help the administration in following ways:

- To monitor the situation on all the data bases.
- What actions should be taken to get the best output from the particular area?
- To supervise the teaching, learning and evaluation process. To plan and make the various schedules for exams, events, activities etc.
- To check assignment/ Exam/ Assessment marking process.
- To check students learning and monitor the progress report.

5.4 Assignment Agent

They have to remind the teachers to upload the question-paper/ quiz/ notes/ project/ assignment/ MCQ. According to the schedule agent's clones keep on moving to all the subject teachers and as soon as they upload the study material they collects them and sends them to the assignment database. Until they submit the assignment/exam paper/ MCQ/ online quiz, till then they remains in one of the states:

- Wait for submission.
- Move to new location & come back later.
- Force the teacher to submit the study material. Then agents will send the material to the student database. And same way they get the assignment from the student database after completions and then send them to evaluation database.

It also reminds the student:

- How much time is left if it is an online test?
- Before how long they have got the assignment.
- How much work they have completed on their project/assignment etc.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

5.5 Webzine Agents

There will be agents to check if the students have uploaded something on webzine like:

- Composes poems of lyrics.
- Writes short stories.
- Writes literary criticisms.
- Appreciates well written or spoken pieces representing various genre's (prose, poetry, plays)
- Expresses ideas and opinions creatively in different forms.
- Display originality of ideas and options.

A student will be inspiring others if their articles have been seen multiple times on the portal; it can also be taken care of by the mobile agents. Then the points will be automatically sent by the mobile agents in their literary & creative skills option.

5.6 Evaluation Agent

The mobile agent will help the administration in the following ways:

- To send the report of complete/incomplete/improper work (done by the student) to the teacher database to take action accordingly.
- To evaluate the objective/MCQ type of answers by itself.
- To send the subjective type of answers to the teacher database along with the last date to submit the list of marks.

5.7 Grade Calculating Agents In Scholastic and Co-Scholastic Areas

Each student will be graded on the scholastic and co-scholastic (life skills, work education, visual & performing arts, attitude and values, literary and creative skills, scientific skills, information and technology, organization and leadership skills, health & physical education activity). These agents will keep on monitoring students' participations and management and if not filled by the teacher the teacher will be reminded, otherwise the relevant grade will be filled in result by mobile agents. While if the entries are complete but the student does not pass, the report will be sent to the teacher to take the test again.

5.8 Result Publishing Agents

With the help of these agents the results are completed and then published in following ways:

- To give instant scoring.
- To find the best students in all the subjects.
- To find the students who need extra attention.
- To send mail to teacher to tell the performance of the students and to take the action accordingly.
- To get the final marks of after multiple calculation and conversions and then to fill the grades according to the final marks and then to show relevant indicators according to the subjects.
- To remind the teacher in which particular area all the students are facing what kind of problems and needs more attention.
- To remind the student in which particular area they are having problems & the guidelines to solve them.

6. CONCLUSION

A mobile agent is a program, which represents a user in a computer network, and is capable of migrating autonomously from node to node, to perform some computation on behalf of the user. Mobile agents are defined as objects that have behavior, state, and location .Its tasks are determined by the agent application, and can range from simple searching to complete teaching-learning-evaluation process. Modern Evaluation Applications can inject mobile agents into a network, allowing them to roam the network either on a predetermined path, or one that the agents themselves determine based on dynamically gathered information to make the maximum use of teachers' time with which the students can be benefitted more. Having accomplished their goals, the agents will return to their origin in order to report their results to the user. Modern Teaching, Learning and Evaluation system would benefit from the development of agent-based capabilities. The resulting intelligent continuous evaluation systems will use a variety of intelligent agents.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

We also saw that, in these environments it is necessary to give support to the learner in several tasks, and some of them can be better assisted by an IR system such as that involve query and information gathering to aid learners on handling questions.

This article conceptualizes different types of intelligent agents to assist teachers and students like Administrator Agents, Teaching Agents, Scholastic Agents, Co-Scholastic Agents, Evaluation Agents, Result Publishing Agents, and Defaulter Agents. Developing intelligent continuous evaluation systems that incorporate these agents will offer some challenges, as well.

REFERENCES

[1] Alfonso Fuggetta, Gian Pietro Picco and Giovanni Vigna, Understanding Code Mobility, *IEEE Transactions on Software Engineering* 24(5), 1998.

[2] I. Ahmed, M. J. Sadiig, An autonomous mobile agent based distributed learning architecture- A Proposal and Analytical Analysis, 6 (4), 2010.

[3] Boy, G.A., Software agents for cooperative learning, in Software Agents, *Bradshaw J.M. AAAI Press/MIT Press*, 1997.

[4] Chia-En Lin, Krishna M. Kavi.Frederick T. Sheldon and Thomas E. Potok, A Methodology to Evaluate Agent Oriented Software Engineering Techniques, *The International Journal of Multiagent and Grid Systems*, 2005.

[5] Kinshuk, Taiyu Lin, Improving mobile learning environments by applying mobile agents technology.

[6] Lange, D.B., Mobile objects and mobile agents: the future of distributed computing, *The European Conference on Object-Oriented Programming (ECOOP), Brussels, Belgium*, 1998.

[7] Danny B. Lange and Mitsuru Oshima, Seven Good Reasons for Mobile Agents, *Communications of ACM*, 42 (3), 1999.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS
J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.77-82 (2011)

Impact of Ethics on Innovations and Applications in Engineering, Applied Sciences and Society

Dinesh Chandra Semwal
Shriram Institute of Management & Technology, Kashipur (USN), India
(**Email:** semdinesh@gmail.com)

ABSTRACT- Ethics is the field of study that is concerned with questions of value that is judgments about what human behaviour is good or bad. Ethics is more than just the "Golden Rule". It is a principle of what is right and wrong. Everybody knows it's wrong to lie, cheat, steal, etc. Society is increasingly finding itself in conflict because of the ethical dilemmas caused by engineering and technology. Computer ethics or engineering ethics are rapidly growing societal issues; a significant uncertainty is the impacts it has on the values of privacy and security. In this article, different situations have been shown which clearly show right from wrong associated with engineering & computer technology.

1. INTRODUCTION

Engineering is an art, a science, Design, a profession and a business. It is the practice of making good on the promise of technology. The science of morals in human conduct (from the Greek 'Ethos'-charac'teristic spirit or attitudes of a community, people or system), while the ethics of a Engineer will always reflect the cultural values, including morality, of his or her professional and personal worlds.

Engineering ethics is the system of moral principles that apply to the practice of engineering and Technology. The field examines and sets the legal & moral binding by engineers to their profession, to society and to their clients. As an intellectual discipline, it is closely related to subjects such as the philosophy of science, the philosophy of engineering, and the ethics of technology. Engineering ethics is a form of applied ethics that examines ethical principles and moral or ethical problems that arise in innovation and application in engineering and applied sciences environment and it is the Study of related questions about moral ideals, character, policies and relationship of people and corporations involved in Technological activity.

Computer ethics is the analysis of the nature and the social impact of computer technology and the corresponding formulation & justification of policies for the ethical use of technology. Ethics cover both social as well as personal policies for the ethical use of technology.

Part of the problem is technology has outpaced society's ability to clearly label right from wrong. While many issues really only require someone to apply their common sense, some issues require deeper thought and analysis before determining right from wrong. It is our responsibility to give thought to the wise & responsible use of technology which is used to base one's decisions or actions on; often there is no clear "right" or "wrong" answer. Because ethical behaviour implies free choice, it cannot be captured in rule. The standard of reference for what is ethical has to exist 'outside human definition', and therefore cannot be open to human negotiation.

Ethics, which addresses precisely such concern, is not about rules or about 'code of conduct'. Both can help everyone, but ethics is about making free choices. Ethics is about behaviour and about ways of thinking, especially in situations where our choice can affect the dignity and well being to others. Because ethical behaviour implies free choice, it cannot be captured rule. The standard of reference for what is ethical has to exist 'outside human definition' and therefore cannot be open to human negotiation. Some may know that standard as Human Rights, some may know it as the Seven Virtues, some may know it as the Ten Commandments, and some may know it by yet another name. It is impossible to force adherence to that standard: the notion of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

coercion itself is foreign to it. But individually we can make a promise to abide by it.

An engineering organization is also a system which uses resources such as man power, capital, materials and facilities. Under the control of rules regulations and engineering/technological ethics to attain the goal of making profit and social benefits, engineering procedure such as order handling, market research & designing, financial planning and manufacturing are the interactions that need to be managed to achieve the objective and for this we need to study the engineering /technological ethics and organizational behaviors.

2. S. PRAKASH SETHI'S 3 LEVELS OF ORGANIZATIONAL ETHICS [1]

Social obligation: the company does not wish to extend its activity any further than just meeting its legal responsibilities – its main purpose is seen as economic.

Social responsiveness: the company adjusts its policies according to the social conditions, demands and pressures- its purpose is seen as both economic and social.

Social responsibility: while the company still sees its purpose as both economic and social, it undertakes the obligation to anticipate upcoming social problems and to work actively to prevent their appearance.

The members of the IEEE, accepting a personal obligation to their profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree [2]:

- to accept responsibility in making decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;
- to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
- to be honest and realistic in stating claims or estimates based on available data;
- to reject bribery in all its forms;
- to improve the understanding of technology, its appropriate application, and potential consequences;
- to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
- to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;
- to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;
- to avoid injuring others, their property, reputation, or employment by false or malicious action;
- to assist colleagues and co-workers in their professional development and to support them in following these code of ethics

Ethics in Computer Science Technology is not about computers; it is about people, even though many may point an accusing finger at computers for such things as threats to privacy. Computer /Technological ethics is the analysis of the nature and the social impact of computer/Technology and the corresponding formulation and justification of policies for the ethical use of Computer/Technology. Ethics cover both social as well as personal policies for the ethical use of Computer/ technology.

"Every new technology has introduced not only new opportunity but also new risk."

The Human challenge has always been to learn to choose well between the indiscriminate use – and – abuse of technological advances as toys or worse and the deliberate application toward the betterment of mankind:

- Fire can be used to cook food or to burn village.
- Wheels can be used to transport goods and people and to build war chariots.
- Chemistry enables us to produce sulfa drugs and sarin.
- Physics gave us electricity and the atom bomb.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

3. WHY SHOULD ONE BE ETHICAL?

There is already something odd about this question. It is like asking, "Why are bachelors unmarried?" They are unmarried by definition. If they were married, they would not be bachelors. It is the same with ethics. To say that one should do something is another way of saying it is ethical. If it is not ethical, then one should not do it.

Perhaps when business or technical people ask why they should be ethical, they have a different question in mind: what is the motivation for being good? Is their something in it for them?

It is perfectly all right to ask if there is a reward for being good, but this has nothing to do with whether one should be good. It makes no sense to try convincing people that they should be good by pointing to the rewards that may follow. One should be good because "good" is, by definition, that which one should be.

As for motivation, good behavior often brings a reward, but not every time. Think about it. If it were always in one's interest to be good, there would be no need for ethics. We could simply act selfishly and forget about obligation. People invented ethics precisely because it does not always coincide with self interest [3].

4. ETHICAL DECISION MAKING

The UK Institute of Business Ethics suggests a simple 'test' for ethical decision-making in business:

Transparency: am I happy to make my decision public - especially to the people affected by it?

Effect: have I fully considered the harmful effects of my decision and how to avoid them?

Fairness: would my decision be considered fair by everyone affected by it (consider all stakeholders - the effects of decisions can be far-reaching).

If you can honestly answer *Yes* to each of the above questions then you are likely to be making an ethical decision. [4]

4.1 The Fundamental Principles [5]

Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

- Using their knowledge and skill for the enhancement of human welfare;
- Being honest and impartial, and serving with fidelity the public, their employers and clients;
- Striving to increase the competence and prestige of the engineering profession; and
- Supporting the professional and technical societies of their disciplines.

4.2 The Fundamental Canons

- Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
- Engineers shall perform services only in the areas of their competence.
- Engineers shall issue public statements only in an objective and truthful manner.
- Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
- Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
- Engineers shall act in such a manner as to uphold and enhance the honor, integrity and dignity of the profession.
- Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional development of those engineers under their supervision.

5. THREE ETHICAL MODELS OF ENGINEERING

- Malpractice, or Minimalist, Model
- Reasonable-Care, or Due-Care, Model
- Good Works Model

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

5.1 Malpractice, or Minimalist, Model

This is a minimalist model in which the professional is concerned only with meeting standards and requirements of the profession and any other laws or codes that apply. This model looks to find fault when problems or accidents arise from someone's failure to meet a requirement.

5.2 Reasonable-Care or Due-Care, Model

A model of engineering practice in which the engineer is expected to take reasonable precautions or care in the practice of his profession and work. The model strives to prevent harm, and it appeals to a "standard of reasonableness as seen by a normal, prudent nonprofessional."

5.3 Good Works Model

A model of engineering practice in which engineers go beyond the basics of what is required by standards and codes and do what they "ought" to do to improve product safety, social health or social well-being.

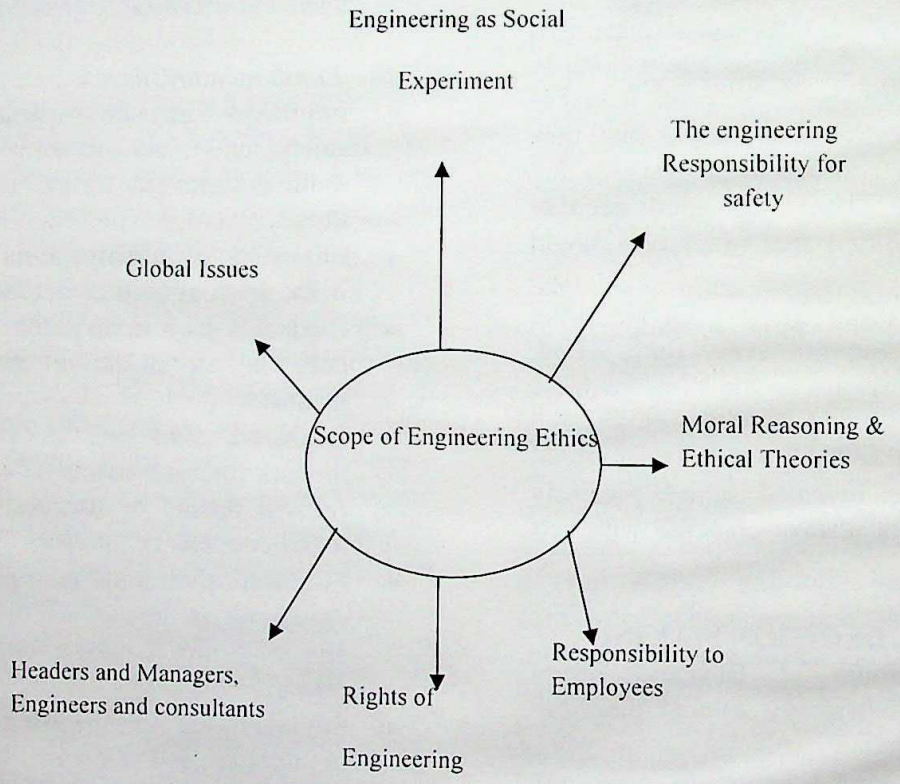

Engineering as Social Experiment
The engineering Responsibility for safety
Global Issues
Scope of Engineering Ethics
Moral Reasoning & Ethical Theories
Headers and Managers, Engineers and consultants
Rights of Engineering
Responsibility to Employees

Fig. 1: Scope of Engineering Ethics

Even granting that Engineering / computer ethics is important, many seem to believe that there is no point in studying the subject. Ethics is something you feel, not something you think. Production, manufacturing, operations, and even engineering /cyber law lend themselves to intellectual treatment, but ethics does not.

The idea that ethics has no intellectual content is odd indeed, considering that some of the most famous intellectuals in world history have given it a central place in their thought (Kautiliya, Confucius, Plato, Aristotle, Maimonides, Thomas Aquinas, etc.). Ethics is in fact a highly developed field that demands close reasoning. The Western tradition in particular has given rise to sophisticate deontological, teleological and consequentiality theories of right and wrong. No one theory explains everything satisfactorily, but the same is true, after all, in the natural sciences.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Even when they grant that ethics has intellectual content, people often say that studying the field will not change behavior. Character is formed in early childhood, not during a professor's lecture.

This is again a curious view, since ethics is the one field that deals explicitly with conduct. Where is the evidence for this view? The early origins of character do not prevent finance, engineering and Computer courses from influencing behavior. Why cannot ethics courses also have an effect?

Ethics courses have a number of features that seem likely to influence behavior. They provide a language and conceptual framework with which one can talk and think about ethical issues. Their emphasis on case studies helps to make one aware of the potential consequences of one's actions. They present ethical that theories help define what a valid ethical argument looks like. They teach one to make distinctions and avoid fallacies that are so common when people make decisions. They give one an opportunity to think through, at one's leisure, complex ethical issues that are likely to arise later, when there is no time to think. They introduce one to such specialized areas as product liability, employment, intellectual property, environmental protection, and cross-cultural management. They give one practice at articulating an ethical position, which can help resist pressure to compromise.

Ethics not only should be studied alongside Engineering and Applied Sciences or management, but the all fields are closely related. Every field is all about making the right decisions in the respective fields. Ethics is all about making the right decisions. This is why scientists, research scholars, students, teachers, and all the person related to the different fields should study ethics.[6]

6. THE SULLIVAN PRINCIPLES – 1977

- Non-segregation of the races in all eating, comfort, and work facilities.
- Equal and fair employment practices for all employees.
- Equal pay for all employees doing equal or comparable work for the same period of time.
- Initiation of and development of training programs that will prepare, in substantial numbers, blacks and other nonwhites for supervisory, administrative, clerical, and technical jobs.
- Increasing the number of blacks and other nonwhites in management and supervisory positions.
- Improving the quality of life for blacks and other nonwhites outside the work environment in such areas as housing, transportation, school, recreation, and health facilities.
- Working to eliminate laws and customs that impede social, economic, and political justice (added in 1984) [7].

There are lot of crimes with dangerous consequences by using the Engineering and applied sciences without ethical values. People who are extremely bright with computers or Applied Sciences sometimes use their abilities for evil. They create programs or bugs or products or medicines to destroy the Human ability [8].

7. CONCLUSION

Discussing ethics is not against technology, nor against "progress", but failures, disasters, accidents, misuse of technology in the past, with or without conscience intentions, by engineers must open the discussion about "good" technology and the orientation and direction of what is meant by "technological progress". Ethics has a long tradition that can help in this evolution. Recent evolutions on "business ethics" and engineering ethics" proof this. Ethics and technique should be partners in the struggle for a better world.

Even the new kind of legislation (e.g. European Directives) opens this debate: since 1992 Europe asks to implement the "precautionary principle". Legislation is less casuistic, and presents more frameworks that invite the 'actors' to behave as "good housekeepers", to make a choice for "the best

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

available technology", to sustain "sustainable" technology, an invitation to engineers to use their 'genius', their creativity by difficult choices [9].

REFERENCES

[1] S.P. Sethi, Dimensions of Corporate Social Performance: An Analytical Framework, *California management Review* 17, 1975.

[2] Approved by the IEEE Board of Directors February, 2006.

[3] Why Business Ethics? John Hooker, Carnegie Mellon University, April 2003.

[4] Source: http://www.ibe.org.uk/tests.html

[5] Engineering Ethics: An introductory course By Herman LODEWYCKX, M.Ph. Brno, FME, May 2008.

[6] Why Business Ethics? John Hooker, Carnegie Mellon University, April 2003.

[7] Ethics in Management: UEL University of East London, BME leadership and management development programme.

[8] Shyam Bhatawdekar's website: http://shyam.bhatawdekar.com

[9] Management Encyc*lopedia,* Management Universe:

[10] http://management-universe.blogspot.com

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences
ISSN 097-3799
JNPS
J.Nat. & Phys. Sc.
Vol. 24, No.1, pp.83-87 (2011)

Sanskrit: A Programming Language

Suyash Bhardwaj[1#] and Poornima Tyagi[2]
[1]*Department of Computer Science & Engineering, Faculty of Engineering and Technology, Gurukul Kangri Vishwavidyalaya, Haridwar, India*
[2]*Department of Computer Science, Vishveshwarya Group of Institutes, Ghaziabad, India*
[#]Corresponding author (**Email**: suyash.bhardwaj@gmail.com)

ABSTRACT- Sanskrit is a historical Indian language contrasted with the languages spoken by the people, *Prakrit* - Prototype, natural, artless, normal, ordinary. The Sanskrit language, whatever its antiquity, is of a wonderful structure; more perfect than the Greek, more copious than the Latin, and more exquisitely refined than either. The major benefit of Sanskrit is that it is clear in speech, perfect in pronunciation, articulate in conversation, sharp in memory, rapid in thinking, logical in analysis, rational in understanding, accurate in expression and communication, familiarity with a wide variety of concepts. This paper suggests that the aspects of Sanskrit structure have implications for further advance in computer science, knowledge representation, and linguistics. In particular we can hope for significant applications in natural language processing. The Sanskrit based processing tools can be developed, which can assist not only those who are not comfortable in programming but also those who have innovative ideas however to be implemented. This paper discusses the features of the Sanskrit language which makes it a unique yet sophisticated language to be used in natural language processing.

KEYWORDS : Knowledge Representation, Linguistics, Natural Language Processing.

1. INTRODUCTION

The word **sanskrita**, meaning "*refined*" or "*purified*," is the antonym of *prakrita*, meaning "*natural*," or "*vulgar*." It is made up of the primordial sounds, and is developed systematically to include the natural progressions of sounds as created in the human mouth.

Sanskrit was considered as *"Dev Bhasha"*, *"Devavani"* or the language of the Gods by ancient Indians. There are 54 letters in the Sanskrit alphabet. Each has masculine and feminine, *shiva* and *shakti*. 54 times 2 is 108.

Panini is known for his Sanskrit grammar, particularly for his formulation of the 3,959 rules of Sanskrit morphology in the grammar known as *Ashtadhyayi* (meaning "eight chapters"), the foundational text of the grammatical branch of the *Vedanga*, the auxiliary scholarly disciplines of Vedic religion [1].

Panini (c 400BC), in his *Astadhyayi*, gave formal production rules and definitions to describe Sanskrit grammar. Starting with about 1700 fundamental elements, like nouns, verbs, vowels and consonants, he put them into classes. The construction of sentences, compound nouns etc. was explained as ordered rules operating on underlying fundamental structures. This is exactly in congruence with the fundamental notion of using terminals, non-terminals and production rules of modern day computer science. On the basis of just under 4,000 *sutras* (rules expressed as aphorisms), he built virtually the whole structure of the Sanskrit language. He used a notation precisely as powerful as the Backus normal form, an algabraic notation used in Computer Science to represent numerical and other patterns by letters.

Sanskrit was created and then refined over many generations (traditionally more than a thousand years) until it was considered complete and perfect.

It is generally written in the syllabic Devanagari script composed of 51 letters or aksharas. The Sanskrit language, whatever be its antiquity, is of a wonderful structure; more perfect than the Greek, more copious than the Latin, and more exquisitely refined than either.

The Sanskrit language has helped shape many European languages including French, German, Russian, and English. It shows many ancient forms of words such as father, through,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

shampoo, trigonometry, and mouse, while guru, pundit, *dharma, bandh,* and *yoga* are among hundreds of Sanskrit words that can now be found in the Oxford dictionary.

2. FORMS OF SANSKRIT

There are various forms of Sanskrit. A few of them are discussed as under:-

2.1 Vedic Sanskrit

Vedic Sanskrit is the language of the Vedas, a large collection of hymns, incantations (*Samhitas*), theological discussions, and religio-philosophical discussions (*Brahmanas, Upanishads*) which are the earliest religious texts of the Hindu religion.

2.2 Classical Sanskrit

The Vedic form survived until the middle of the first millennium BC. Around this time, as Sanskrit made the transition from a first language to a second language of religion and learning, the Classical period began. It is a significant form of post-Vedic Sanskrit and is found in the Sanskrit of the Hindu Epics-the Ramayana and Mahabharata. There have been *"prakritisms"* (borrowings from common speech) in this form of Sanskrit. Classical Sanskrit became fixed with the grammar of Panini (roughly 500 BC), and remains in use as a learned language until the present day [1,2].

3. SANSKRIT AND THE COMPUTING

It is evident that the ancient scientists of language were acutely aware of the function of language as a tool for exploring and understanding life, and their intention to discover truth was so consuming that in the process of using language with greater and greater rigor, they discovered perhaps the most perfect tool for fulfilling such a search that the world has ever known-the Sanskrit language.

According to the research done by NASA research centre during their study on using natural language for computer processing. They explained that Sanskrit is most suitable natural language for it. Sanskrit is the only language which1000 years old. Besides works of literary value, there was a long philosophical and grammatical tradition that has continued to exist with undiminished vigour until the present century.It is discovered that Sanskrit, the world's oldest spiritual language, is the only unambiguous spoken language on the planet is suitable natural language processing, thata natural language can serve as an artificial language and work can be done in Artificial Intelligence.

3.1. Specialty of Sanskrit Language

It is a natural language. There is a direct link between the sound and signs; it is phonetic. We write Sanskrit exactly as we say which means that the writing of Sanskrit language is based on the sound of the spoken form.

There is only one set of alphabet in Sanskrit. This avoids many complexities of writing capital/small and italic letters as they are in the Roman alphabet/European scripts. There aren't many punctuation marks found in Sanskrit (*Devanagari*) script. For writing Sanskrit language, any comprehensive alphabet can be used and vice versa. There is an easy-flowing, natural and logical way to proceed while learning this wonderful language or to write any language after that. Sanskrit sentence structure is flexible. The declensions and the conjugations have a wide range. Hence every student has more freedom in composing sentences in Sanskrit. In Sanskrit, the order of words in a sentence does not matter [3].

3.2 Benefits of the Sanskrit Knowledge

Sanskrit is the oldest language of our planet. The major benefit of Sanskrit is that it is clear in speech, perfect in pronunciation, articulate in conversation, sharp in memory, rapid in thinking, logical in analysis, rational in understanding, accurate in expression and communication, familiarity with a wide variety of concepts. In this modern age of computers, Sanskrit has one more thing to offer, adoption of the already computerized contents or the Sutras in many of its technical subjects like Panini's *Ashtadhyayi-* the text book of grammar. Since both Sanskrit and the computer are having fewer irregularities, if not perfect, their combination should work marvelously for the benefit of mankind. In other words, understanding and appreciation of numerous Indian things whether music, dance, arts, rituals, tradition, religions, values, languages,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

science etc. will be easy for one who knows Sanskrit. The integrity of the Indian elements owe essentially to the Sanskrit language and literature which has the universal impact upon them.

3.3. A Complete Grammar and Limitation of Language

The *Ashtadhyayi* is a grammar of the *Sanskrit* language by *Dakshiputra Panini* that describes the entire language in 4,000 algebraic rules. The structure of this grammar contains a meta-language, meta-rules, and other technical devices that make this system effectively equivalent to the most powerful computing machine. No grammar of similar power has yet been constructed for any other language since. The famous American scholar Leonard Bloomfield called Panini's achievement as *"one of the greatest monuments of human intelligence"*.

The other side to the discovery of this grammar is the idea that language (as a formal system) cannot describe reality completely. This limitation of language, the *rishi* tell us, is why the Truth can only be experienced and never described fully [2,3].

4. SANSKRIT AS COMPUTER PROGRAMMING LANGUAGE

Panini's grammar consists of nearly 4,000 rules divided into eight chapters. It provides a collection of 2,000 roots. Being composed with the maximum conceivable brevity, this grammar describes the entire Sanskrit language in all the details of its structure, with a unity which has never been equated elsewhere. It is at once the shortest and fullest grammar in the world."

Panini's grammar is notably descriptive, Panini was only concerned with what people actually did say and write." This underscores the point about Sanskrit as a natural language. Sanskrit's potential for scientific use was greatly enhanced as a result of the thorough systemization of its grammar by Panini. On the basis of just under 4000 sutras [rules expressed as aphorisms], he built virtually the whole structure of the Sanskrit language, whose general 'shape' hardly changed for the next two thousand years.

An indirect consequence of Panini's efforts to increase the linguistic facility of Sanskrit soon became apparent in the character of scientific and mathematical literature," i.e. that the flourishing of Indian Sub continental mathematics may have been a direct consequence of the systematization of the grammar of Sanskrit, and of the formal tools which were developed in order to do this.

It is suggested that the aspects of Sanskrit structure will have implications for further advance in computer science, knowledge representation, and linguistics. In particular we can hope for significant applications in natural language processing. The ongoing analysis of the structures of *Paanini* and those of the later grammarians and logicians will be aided by the development of software to implement it on a digital computer.

The specific issues of immediate interest to the computer scientist include analysis of the arrangement of the rules and search for other arrangements that are equivalent in terms of their generative power. The formal aspects of these arrangements and their relationships are likely to help increase the notion of distance between grammars.

The linguistic perfection of Sanskrit offers only a partial explanation for its sustained presence in the world for at least 3,000 years. High precision in and of itself is of limited scope; like mathematics, it generally excites the brain, but not the heart. Like music, however, Sanskrit has the power to uplift the heart. It's conceivable that for a few rare and inspired geniuses, mathematics can reach the point of becoming music or music, mathematics.

Computer oriented studies on Sanskrit would also help to introduce AI (artificial intelligence), logic, and cognitive science as additional areas of study in the Sanskrit departments of universities. This would allow the Sanskrit departments to complement the program of the computer science departments. With the incorporation of these additional areas, a graduate of Sanskrit could hope to make useful contributions to the computer software industry as well, particularly in the fields of natural language processing and artificial intelligence [4,5].

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

4.1 Scientific and Systematic Language

The Sanskrit alphabet is called *"devanagari"* and literally means "cities of the gods". Rishis discovered Sanskrit and used it to create the mantras. These mantras were made up of a combination of sound vibrations, which when recited had a specific effect on the mind and the psyche. In the times of the *rishi*, the main aim was to attain the truth, and Sanskrit - the perfect tool was found to be the best medium. Due to its specificity and purity, this seemed the best language with which to understand God's creation and as such is called "the great spiritual language of the world" (Joseph Campbell). Sanskrit is the common language of the texts. It is the oldest language in the world. It is the language of the *Vedas, Upanishads, Bhagavad Gita, Mahabharata* , *Ramayana* and the *Puranas*. Sanskrit literature is easily the richest literature in the history of mankind. The word Sanskrit literally means "Perfected Language" or "Language brought to formal perfection". This is quite an appropriate name since NASA declared it to be "the only unambiguous language on the planet". Sanskrit is a scientific and systematic language. Its grammar is perfect and has attracted scholars worldwide. Recently well-known linguists and computer-scientists have expressed the opinion that Sanskrit is the best language for use with computers. Sanskrit has a perfect grammar which has been explained to us by the world's greatest grammarian Panini.

4.2 A Structured Language

Lakshmi Thathachar's view of Sanskrit's nature may be paraphrased as follows: All modern languages have etymological roots in classical languages. Words in Sanskrit are instances of pre-defined classes, a concept that drives object oriented programming [OOP] today. For example, in English 'cow' is a just a sound assigned to mean a particular animal. But if you drill down the word *'gau'* -Sanskrit for 'cow' - you will arrive at a broad class *'gam'* which means to move. From these derive *'gamanam', 'gatih'* etc which are variations of 'movement'. All words have this OOP approach, except that defined classes in Sanskrit are so exhaustive that they cover the material and abstract-indeed cosmic-experiences known to man. So in Sanskrit the connection is more than etymological.

It was Panini who formalized Sanskrit's grammar and usage about 2500 years ago. No new 'classes' have needed to be added to it since then. "Panini should be thought of as the forerunner of the modern formal language theory used to specify computer languages," say J J O'Connor and E F Robertson. Their article also quotes: "Sanskrit's potential for scientific use was greatly enhanced as a result of the thorough systematization of its grammar by Panini. ... On the basis of just under 4000 *sutras* (rules expressed as aphorisms), he built virtually the whole structure of the Sanskrit language, whose general 'shape' hardly changed for the next two thousand years."

Every 'philosophy' in Sanskrit is in fact a 'theory of everything'. The many-strands are synthesized in *Vedanta- Veda + anta-* which means the 'last word in Vedas'. *Mimamsa*, which is a part of the Vedas, even ignores the God idea. The reality as we know was not created by anyone - it always was-, but may be shaped by everyone out of free will. Which is a way of saying- in OOP terms - that you may not touch the mother or core classes but may create any variety of instances of them. It is significant that no new 'classes' have had to be created. Thathachar believes it is not a 'language' as we know the term but the only front-end to a huge, interlinked, analogue knowledge base. The current time in human history is ripe, he feels for India's young techno wizards to turn to researching *Mimamsa* and developing the ultimate programming language around it; nay, an operating system itself [6,7].

5. CONCLUSION

Being the oldest living languages, Sanskrit is the most scientific and unambiguous, according to a study by a NASA scientist Rick Briggs in 1985. Researchers at NASA have been looking at Sanskrit as a possible computer language because of its perfect morphology that leaves very little room for error.

According to Forbes Magazine (1987), "Sanskrit is the most convenient language for computer software programming."

Sanskrit and computers are a perfect fit. The precision play of Sanskrit with computer tools

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

will awaken the capacity in human beings to utilize their innate higher mental faculty with a momentum that would inevitably transform the world. In fact the mere learning of Sanskrit by large numbers of people in itself represents a quantum leap in consciousness, not to mention the rich endowment it will provide in the arena of future communication.

Ancient and classical creations of the Sanskrit tongue both in quality and in body and abundance of excellence, in their potent originality and force and beauty, in their substance and art and structure, in grandeur and justice and charm of speech and in the height and width of the reach of their spirit stand very evidently in the front rank among the world's great literatures. The language itself, as has been universally recognized by those competent to form a judgment, is one of the most magnificent, the most perfect and wonderfully sufficient literary instruments developed by the human mind, at once majestic and sweet and flexible, strong and clearly-formed and full and vibrant and subtle, and its quality and character would be of itself a sufficient evidence of the character and quality of the race whose mind it expressed and the culture of which it was the reflecting medium.

Sanskrit after all is the language of mantra - words of power that are subtly attuned to the unseen harmonies of the matrix of creation, the world as yet unformed. The possibility of such a finely attuned language is only conceivable by drawing upon sounds so inherently pure in combinations so harmoniously blended that the result is as refreshing and pure as the energy of creation forming into mountain streams and lakes and the flawless crystal structures of natural gems, while at the same time wielding the power of nebulae and galaxies expanding into the infinitude of space.

From the perception of Rishis, the source of language transcends such conceptions. In Sanskrit, *vaak*, speech, the "word" of Genesis, incorporates both the sense of "voice" and "word". It has four forms of expression. The first, *paraa*, represents cosmic ideation arising from the original and absolute divine presence. The second, *pashyantii* (literally "seeing") is *vaak* as subject "seeing," which creates the object of *madhyamaavaak*, the third and subtle form of speech before it manifests as *vaikhariivaak*, the gross production of letters in spoken speech.

Sanskrit is a language whose harmonic subtlety, mysteriously sources the successive phases of creation all the way to origination. This implies the possibility of having speech oriented to a direct living truth which transcends individual preoccupation with the limited information available through the senses. Spoken words as such are creative living things of power. They penetrate to the essence of what they describe. They give birth to meaning which reflects the profound interrelatedness of life.

The script used to depict written Sanskrit is known as *Devanagari* or that "spoken by the Gods". Suitably for Sanskrit, it is a perfect system of phonetic representation. According to linguists, the phonetic accuracy of the *Devanagari* compares well with that of the modern phonetic transcriptions.

REFERENCES

[1] The Student's Guide to Sanskrit Composition, A Treatise on Sanskrit Syntax for Use of Schools and Colleges, *Lokasamgraha Press, Poona, India*, 1885.

[2] A concise elementary grammar of the Sanskrit language (Tr. Gordon B. Ford Jr). E. J. Brill, Leiden, 1966.

[3] Structure of a Sanskrit dictionary, Technical report, INRIA, 2000.

[4] From an informal textual lexicon to a well-structured lexical database, An experiment in data reverse engineering, *Working Conference on Reverse Engineering, IEEE*, 127-135 (2001).

[5] Transducers as lexicon morphisms, phonemic segmentation by euphony analysis, application to a sanskrit tagger. http://pauillac. inria. fr/~ huet/ PUBLIC/tagger.pdf, 2002.

[6] The Zen computational linguistics toolkit, Lexicon structures and morphology computations using a modular functional programming language, *Tutorial, Language Engineering Conference*, 2002.

[7] G´erard HuetAutomata mista. In Nachum Dershowitz, editor, Festschrift in Honor of Zohar Manna for his 64th anniversary, *Springer-Verlag LNCS* 2772, 2003.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of Natural & Physical Sciences

Vol. 24, No. 1, 2011

Form-IV
(See Rule 8)

Place of Publication	:	Gurukul Kangri Vishwavidyalaya Haridwar (Uttarakhand)
Periodicity	:	One issue per year, Maximum two issues
Publisher's Name	:	Prof. A.K. Chopra
Nationality	:	Indian
Address	:	Registrar Gurukul Kangri Vishwavidyalaya Haridwar-249404 (Uttarakhand)
Chief Editor's Name	:	Prof. A.K. Chopra
Nationality		Indian
Address		Department of Zoology & Environmental Science Gurukul Kangri Vishwavidyalaya Haridwar-249404 (Uttarakhand)
Managing Editor's Name	:	Dr. L.P. Purohit
Nationality	:	Indian
Address	:	Department of Physics Gurukul Kangri Vishwavidyalaya Haridwar-249404 (Uttarakhand)
Printer's Name	:	Chandra Kiran Saini
Nationality	:	Indian
Address	:	Kiran Offset Printing Press Near Gurukul Kangri Pharmacy Kankhal, Haridwar 249404 (Uttarakhand)
Proprietor	:	Gurukul Kangri Vishwavidyalaya 249404 (Uttarakhand)

पुस्तकालय
132082
गुरुकुल कांगड़ी विश्वविद्यालय

I, **Prof. A.K. Chopra** hereby declare that the particulars given above are true to the best of my knowledge and belief.

Sd/-
(Prof. A.K. Chopra)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

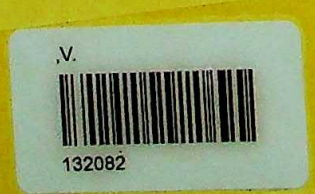
Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri



CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

GURUKUL KANGRI LIBRARY		
	Signature	Date
Access No.		22/8/15
Class No.		
Cat No.		
Tag etc		
E.A.R.		
Recomm. by.		
Data Ent. by		22/9/15
Checked		

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar